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DISTRIBUTION OF MAMMALS IN COLORADO

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DISTRIBUTION OF MAMMALS
IN
COLORADO

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PREFACE

By way of foreword, I wish to anticipate a question that must occur to the reader: Why is such a work undertaken? The question obviously is appropriate in a day when an eminent systematist (Mayr, 1971:428) may say "Faunistic or floristic papers . . . , particularly if a politically defined area is involved, rarely lead to worthwhile generalizations." This is, to be sure, a faunistic study of a political unit. Can it be justified? Surely studies of this kind have justification in general; hopefully the present study will find justification in particular.

I first entertained the idea of this study in the fall of 1964 when, as an undergraduate student in mammalogy, I was impressed by the lack of a detailed distributional checklist of Coloradan mammals. My interests then came to focus on historical and ecological zoogeography of the mountainous regions of western North America. The Coloradan fauna seemed to be an obvious keystone in zoogeographic patterns in the area, but no published source provided the details necessary to fit the fauna into the broader picture. A distributional checklist would fill an obvious void, at the same time providing a basis for a study of zoogeographic patterns in a diverse, historically complex (and familiar) area.

Colorado is a "politically defined area" equalled in the United States only by Utah and Wyoming, in that all of the state's boundaries are geometric artifacts; none follows a natural barrier. As this study of distributional areas progressed, however, it became obvious that some boundaries of Colorado do, in fact, approximate boundaries somehow inherent in the landscape. Species were seen to occur steadily northward along the eastern mountain front only to terminate abruptly, almost within view of the Wyoming boundary (despite the best efforts of Wyoming-based students to augment their faunal list). In other cases, populations were observed to show subspecific differentiation with only a political boundary between them. It seemed at times that the squirrels were conspiring to take sides in the intrigues of mammalogists on the subspecies question. I never decided, however, where they stood.

That purely political boundaries coincide at times with natural boundaries obviously is an historic accident, as irrelevant as it is interesting. However, the observation did provide standard repartee for the standard question, "Why Colorado?"

In zoogeographic studies, to label an area political or otherwise misses part of the point. The point is, does the area suffice? Is the unit a pragmatic choice? Zoogeography, like ecology, is a study of patterns in space and time. Ecologists frequently select arbitrary units for study. Such units must be large enough to include any existing synecological patterns, and diverse enough to allow a range of variation. But they must remain sufficiently small so that logistic problems are not insurmountable. Subjective decisions are made and a study area is selected. Zoogeographers do the same. Colorado is a zoogeographic study area, one of remarkable interest.

The foregoing thoughts underlay the initiation of this study, and their occasional recurrence provided some of the momentum that sustained the enterprise. They were the working justification, but recently a more basic justification has become clear. Such a study is, certainly, an interim report, if only because the systems described are dynamic. In view of the dynamism of zoogeographic patterns, it is sobering to realize that what was natural history yesterday may be plain history tomorrow. Perhaps our efforts today are salvage zoology. The fact is that, at this writing, large areas of Colorado are being subdivided and paved with all deliberate haste. It is estimated that nearly two million acres in the state presently are undergoing subdivision. The foothills and lower mountains of the Eastern Slope bear the brunt of this trend at its frenetic worst. Yet it is just those areas that support the most complex biotic communities in the region, at the favored interface between mountains and plains.

I do not doubt that development is inevitable. It will deeply affect every kind of ecosystem in the state. However, I do doubt that novel land use can ignore highly evolved natural systems. The evolution of a biotic community represents the accumulation of information as species adjust to each other against a dynamic physical setting. To say that a community has emergent properties is no mere hyperbole. The whole is greater than a simple sum of parts; the evolution of mutual adjustments makes it so.

Could we but read the meter, we would find that the biotic community is, in fact, the most comprehensively sensitive indicator of the conditions of a given site. No replacement community can be successful over the long run if the natural tendencies of the site are ignored. The same is true of replacement land use over broader areas, involving more inclusive biotic communities.

Once disrupted by extinction or artificial simplification, the symbiotic information in a given natural system is irretrievable. We had better begin to understand the history and potential of the landscape while it is at least partially intact. Perhaps this work will suggest to other students a place to begin.

In closing (but hardly as an afterthought), I wish to dedicate this publication to the most inspiring teacher I have had, the late Professor Robert R. Lechleitner of Colorado State University. He wouldn't have liked parts of the study; for one thing, he didn't trust subspecies, for reasons of his own. But I think that he might have used the maps to a worthy end.

David M. Armstrong
Boulder, Colorado
24 January 1972

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INTRODUCTION

Colorado is the highest of the United States, with a mean elevation of some 6800 feet. The highest and lowest places in the state are separated by more than 11,000 feet of relief, encompassing a spectrum of ecological conditions surpassed in few areas of comparable size in North America.

Colorado embraces a zone of contact between mammalian faunas of the Great Plains, the southwestern deserts, and the Rocky Mountains. The diverse environment supports a resident fauna of 118 species of native mammals. Distributional areas of species typically are large and continuous, but are bounded by pronounced barriers; as a consequence, recurrence of distributional patterns is the rule. The purpose of this study is to describe the distribution of Coloradan mammals, to outline salient aspects of infraspecific variation within the state, to identify and describe recurrent patterns of distribution and variation, and to suggest the possible ecological and evolutionary histories of the patterns observed.

Colorado stands as a keystone in distributional patterns of mammals in western North America. However, the most recent distributional study of Coloradan mammals was published some 60 years ago (Cary, 1911), and was based on the known occurrence of perhaps 3000 specimens. An unpublished thesis by Lewis (1952) is the only subsequent analysis of mammals of the state. A detailed distributional treatment of Coloradan mammals is needed to bring documentation to the level of resolution available in Utah (Durrant, 1952), Kansas (Cockrum, 1952), Arizona (Cockrum, 1960), Nebraska (Jones, 1964), Wyoming (Long, 1965), and other western states.

Early explorers of what is now Colorado, from Escalante and Dominguez to Pike, made observations on the native fauna of the area, but they neither preserved specimens nor attempted to survey the smaller mammals. Scientific study of Coloradan mammals was begun by Thomas Say, who accompanied the expedition of Major Stephen Long in 1820.

From 1820 to about 1870, mammalogical reconnaissance in Colorado was pursued as an adjunct to military activity. Specimens were accumulated by expeditions under Fremont, Abert, Pope, and Bryan. The ill-fated Railroad Survey under Gunnison collected mammals along its route. Material accumulated through these activities was published in large part by S. F. Baird (1858 and previously). Later work by government surveys under Wheeler and Hayden led to publications by Coues and Yarrow (1875) and Coues and Allen (1877).

In the 1870's, individual naturalists began to take an interest in Coloradan mammals. Brewer (1871) made notes on a Harvard Mining School Expedition of 1869. Trippe (1874) presented cursory observations on mammals in the Front Range. J. A. Allen (1874) reported on mammals obtained in Park County in 1871, representing the most extensive collections obtained in Colorado to that time. Coues (1879) listed the mammals exhibited by Mrs. M. A. Maxwell of Boulder, at the Philadelphia Exposition and in Washington in 1876 (see Schantz, 1943). The Maxwell collection passed—in part at least—into the collection of Outram Bangs, and today is housed in the Museum of Comparative Zoology, Harvard University. The accounts cited represent the first faunal studies published for parts of Colorado. For a synoptic history of Coloradan mammalogy, see Warren (1911).

The first checklist of mammals of Colorado was published by Warren (1906) and later augmented (Warren, 1908b) to include recent discoveries of the Bureau of Biological Surveys (specimens now in the U.S. National Museum). The first book-length treatment of Coloradan mammals was published by Warren (1910b—see the review by J. A. Allen, 1910). That work was revised and the new edition published posthumously (Warren, 1942). The recent publication of a new natural history of Coloradan mammals by Lechleitner (1969, see review by Armstrong, 1970) updates the semi-technical literature on the fauna.

E. R. Warren (1860-1942) was an engineer whose introduction to Coloradan mammalogy was in the mining camps of northern Gunnison County. His serious interest in mammalogy was fostered by an association with W. L. Sclater, son of P. L. Sclater and son-in-law of General W. J. Palmer. The younger Sclater had planned to write a book on Coloradan mammals, but found his work on the birds employment enough, and challenged Warren to take up the mammals. Warren and C. E. Aiken, the pioneer ornithologist-taxidermist, made of Colorado Springs and the Colorado College Museum the center of natural history in the state. Warren collected and observed mammals in Colorado for more than half a century, publishing three books on the subject, and some 40 shorter papers, in addition to a like number of ornithological studies. The collection of mammals made by Warren now is housed in the Colorado University Museum, Boulder, and is the most useful single such source available to students of Coloradan mammals. For an appreciation of the contributions of E. R. Warren, see Cockerell and Potts (1943).

The work of the Bureau of Biological Surveys in Colorado began in the early 1890's. A concerted effort was mounted between 1905 and 1909, under the leadership of Merrit Cary. Cary (1911) devoted a majority of his excellent report to mammals, and that work remains the only published report dealing primarily with the geographic distribution of the Coloradan fauna.

Since Cary's studies, most mammalogical work in Colorado has been conducted through colleges and universities. The later work of E. R. Warren was done at the Colorado College Museum. T. D. A. Cockerell continued interest in mammals at the University of Colorado (Cockerell, 1911, 1915, 1927). From that institution have come a number of semipopular publications on Coloradan mammals, including a short handbook by Rodeck (1952, see review by Dorst, 1952), and a valuable "Natural History of the Boulder Area" (Rodeck, 1964). At Colorado State University, research in applied mammalogy has been prevalent, beginning with the work of W. L. Burnett on distribution and control of rodents, and continuing through the efforts of R. R. Lechleitner and his students on prairie dogs, and of R. S. Miller, R. M. Hansen, and T. A. Vaughan and their colleagues on ecology of pocket gophers. Personnel of Colorado State University also have been active in research on game animals, in programs that augment and complement the ambitious efforts of the State of Colorado, Division of Game, Fish and Parks.

Personnel of the Museum of Natural History, University of Kansas, have conducted extensive field work in Colorado in the course of both taxonomic and ecological studies (see, for example, Anderson, 1959a, 1961; Douglas, 1969b; Finley, 1958; Youngman, 1958). Recent reservoir-basin surveys by representatives of the universities of New Mexico and Utah have contributed materially to our understanding of Coloradan mammals (see, for example, Durrant and Dean, 1961; Durrant and Robinson, 1962; Harris, 1963; Olsen, 1962).

In addition, public museums have made extensive collections in Colorado. The largest of these, held by the Denver Museum of Natural History, was made by such naturalists as F. W. Miller, J. D. Figgins, R. J. Niedrach, and their colleagues. The work of the Denver Museum has been important in making knowledge of mammals available to the general public (see F. W. Miller, 1932). The American Museum of Natural History and the Carnegie Museum both house important collections from parts of Colorado that are poorly represented in other museums.

My own work on Coloradan mammals began informally during employment in seven summers as a staff member at Boy Scout camps in the north-central part of the state and in adjacent Wyoming. Over those seasons, an increasing part of my responsibility was instruction in natural history and conservation. Studying mammalogy under the late Professor R. R. Lechleitner at Colorado State University in 1964, I was impressed by the lack of any useful reference on the distribution of Coloradan mammals. Association with the Museum of Natural History of the University of Kansas afforded me the resources to understake the present study. Field work in the spring and summer of 1968 and the summer of 1969 was planned to survey parts of the state neglected by earlier workers. My itinerary allowed me to visit parts of the state with which I was not already familiar. Museum research was conducted between 1967 and 1970. Major museums were visited and additional material was borrowed from other institutions for study.

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My graduate committee has consisted of professors W. Dort, Jr., W. E. Duellman, R. S. Hoffmann, A. W. Küchler, and J. K. Jones, Jr., Chairman. Professors Dort and Hoffmann read the manuscript, and all members of the committee have given advice essential to its preparation. Professor Jones has guided this study since its inception, read critically the entire manuscript, and arranged financial and material support necessary to its completion. His aid in all its aspects is greatly appreciated.

METHODS AND MATERIALS

Organization of Systematic Accounts

Ordinal accounts are included to describe diversity in Colorado within a single broad adaptive mode. Note is taken of important comparative studies that treat several members of a given order. Keys are provided to Coloradan mammals and to species of probable or possible occurrence. The keys are of variable originality. All rely to some extent on keys presented by Lechleitner (1969) and those prepared as unpublished teaching materials for use at Colorado State University by R. G. Beidleman, J. C. Cassel, R. M. Hansen, R. R. Lechleitner, and R. G. Van Gelder. Major changes have been made to expand the coverage of the keys and to extend the range of characters used. Species of hypothetical occurrence in Colorado are designated in keys by an asterisk.

An attempt has been made to keep general accounts of species as brief as possible. The primary purpose of the accounts is to establish each species in its ecogeographic context in Colorado. Direct or indirect effects of human intervention on distribution are discussed. In general, other aspects of natural history are treated cursorily or not at all. Citation is made to literature based on the study of a given species in Colorado or adjacent areas. The reader also is directed to general works by Warren (1942) and Lechleitner (1969). The latter handbook includes an extensive bibliography.

Treatment in the annotated distributional checklist is at the level of subspecies (or monotypic species). Emphasis in the present study is on zoogeography, and subspecies are, by definition, geographic units. "A subspecies is an aggregate of phenotypically similar populations of a species, inhabiting a geographic subdivision of the range of a species, and differing taxonomically from other populations of the species" (Mayr, 1969:41). Geographically limited populations with a variety of evolutionary roles have been treated as subspecies. In some instances, the units may, in fact, represent incipient species, but this is not the usual case. Commonly, the subspecies is at most semi-isolated, and intergradation with neighboring populations is demonstrable.

In recent years, a plethora of criticism has been directed at the concept of subspecies. Some of that criticism is well reasoned. The difficulties of the subspecific category were discussed amply by Wilson and Brown (1953). I shall not reopen the argument here. Durrant (1955) has discussed positive aspects of the use of subspecies in the study of mammals. In a given instance wherein it seems to me that arguments against recognition of a subspecies are pertinent (cases of discordant, clinal, polytopic, or microgeographic variation, for example), I have attempted to qualify the nominal taxon accordingly.

A number of rules-of-thumb have been proposed to make subspecies more objective (see, for example, Mayr, 1969:188-193), but, of course, such methods are themselves necessarily arbitrary. Throughout the preparation of the present checklist, I have favored a more inelegant rule, substantially that of D. L. Jameson: ". . . a subspecies should be described only when to fail to do so would obscure more biological truths than would be lost by describing the subspecies" (*in* Jameson *et al.*, 1966:552).

Information on the 211 subspecies or monotypic species presently recognized as occurring in Colorado is entered under the following categories: synonymy, distribution in Colorado, comparisons, measurements, remarks, and records of occurrence (including specimens examined and additional records).

The synonymy includes, in order: 1) citation to the original description of a subspecies (or monotypic species) and a notation of the type locality; 2) citation to the first use of the name combination currently recognized as valid and available; and 3) citation to additional names judged by me to be subjective, zoological synonyms of recognized names where such synonyms are based on Coloradan type specimens, with a notation as to their type locality.

Distribution in Colorado includes a brief statement of the geographic range of a given taxon within the state, and in most cases refers the reader to a distribution map.

Comparisons are made between adjacent Coloradan subspecies and between Coloradan subspecies and those immediately adjacent in other states. Comparisons between species that are often confused are made in general accounts of the species in question. Comparisons herein typically are brief and are based on direct comparisons made by me unless otherwise noted. In essence, the comparison is a statement of why a subspecies has been recognized and how I have recognized representatives of a given subspecies. However, the primary purpose of including comparisons (and measurements) is to document patterns of geographic variation within the state. Any other use that these data may serve is secondary. Comparisons presented doubtless will not suffice in all cases to identity to subspecies a specimen in hand; they are not intended to do so. In most instances, the identification of mammals at a subspecific level of discrimination is unimportant. When it is of interest to identify material (preferably series of specimens) with one or another named race, comparative material is essential. Inasmuch as each account of a subspecies includes a citation to the original description of that taxon and many include references to taxonomic revisions or reviews, brief comparisons should be adequate for the present purposes, which are primarily zoogeographic rather than taxonomic.

Measurements are in metric units unless otherwise noted. External measurements (in millimeters) were read from specimen labels. These are reported in conventional sequence: total length, length of tail, length of hind foot, and length of ear from notch. Internal omissions from this sequence are marked by a dash; when lengths of ears are unavailable, a set of only three measurements is given. The fifth external measurement listed in accounts of bats is the length of the forearm, as measured by me from preserved specimens. Measurements designated "dry" were made by me from museum specimens. When linear measurements have been recorded on a specimen label in inches and lines or inches and tenths of inches, I have converted them to millimeters without comment. Measurements noted as fractions of millimeters have been rounded off.

When available, weights (of wild-caught specimens) are presented, and are in grams unless otherwise noted. Weights in pounds and ounces were not converted to metric

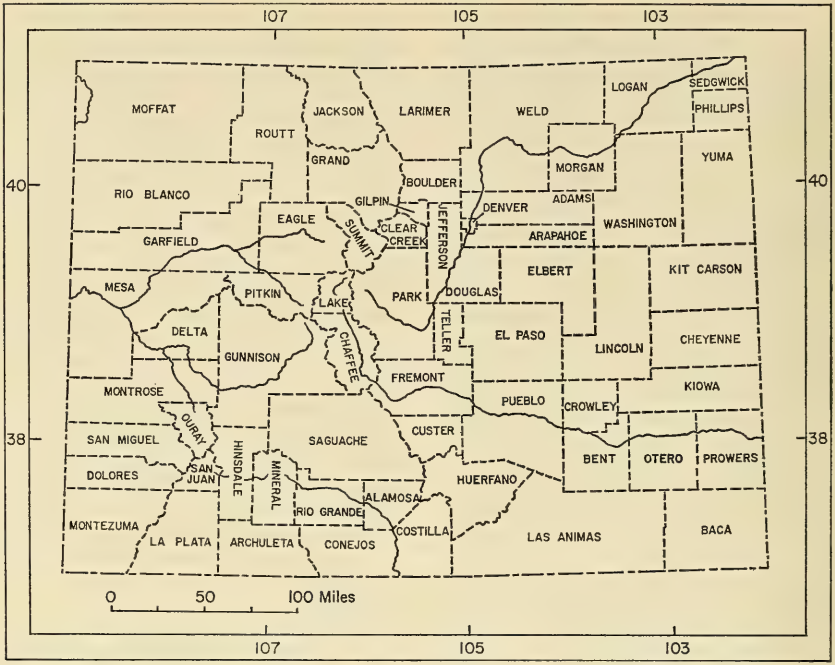


FIG. 1. Map of political boundaries within Colorado, showing names of the 63 counties.

weights, since the sensitivity of the usual pounds-ounces scale is not comparable to that of a metric balance. Pregnant females have been excluded, and weights of immediately pre- or post-hibernating individuals have been avoided.

All measurements reported, unless otherwise specified, are of morphological adults. Adulthood was judged by me on the basis of criteria appropriate to (and readily observable in specimens of) a given taxon. Reproductive maturity precedes morphological maturity in most species of mammals, and reproductive activity is no indication that somatic maturation is complete. Senile, teratological, or otherwise aberrant individuals have not been utilized.

As a convention, to make accounts of species more readily comparable, measurements of males and females are separated. In some cases, differences in size between sexes are significant neither statistically nor (insofar as is known) biologically. In most instances, measurements of a single, more or less local, population are given. Where a taxon is particularly widespread or is subject to microgeographic or other local variation, measurements of samples from more than one local population may be given. Samples of measurements presented generally are representative of the taxon as it occurs in Colorado, but seldom are exhaustive of the available material.

Representative cranial measurements may be noted in text or, when comparison with other kinds is of interest, in tables. Unless otherwise noted, cranial measurements were taken by me, by means of dial calipers, and read to the nearest tenth of a millimeter. Definitions of measurements are those of Hall (1946) unless an exception is noted. In most cases cranial measurements are those of individuals from which external measurements have been reported, but this is not consistently true.

The section headed *Remarks* includes comments relevant to the taxonomy or distribution of a particular subspecies but inapplicable to the species as a whole.

Records of occurrence are the primary data of zoogeographic analysis. This section lists specimens examined by me and additional records from the technical zoological literature. Specimens examined are listed by counties. The 63 counties of Colorado (Fig. 1) are, by convention, listed in approximate order from north to south, with those of the same latitude listed westernmost first. The order is that used in arranging specimens in the Division of Mammals of the Museum of Natural History of the University of Kansas. Such an order is far more meaningful than, say, alphabetic in a state encompassing pronounced regional differences in ecology, because "natural areas" of the state tend to remain together. The order is as follows:

Moffat
Routt
Jackson
Larimer
Weld
Morgan
Logan
Sedgwick
Phillips
Rio Blanco
Garfield
Eagle
Grand
Summit
Boulder
Gilpin
Clear Creek
Jefferson
Adams
Denver
Arapahoe
Washington
Yuma
Mesa
Pitkin
Lake
Park
Douglas
Elbert
Lincoln
Kit Carson
Delta
Gunnison
Chaffee
Teller
El Paso
Cheyenne
Montrose
Ouray
San Miguel
Saguache
Fremont
Custer
Pueblo
Crowley
Kiowa
Dolores
San Juan
Hinsdale
Mineral
Rio Grande
Alamosa
Huerfano
Otero
Bent
Prowers
Montezuma
La Plata
Archuleta
Conejos
Costilla
Las Animas
Baca

Within a given county, localities are listed in order from north to south, with localities at the same latitude listed westernmost first. Many localities may be located on highway maps of Colorado. Official highway maps issued by the State of Colorado Division of Highways are particularly useful because the background shows shaded relief.

Most localities were located on one or more of four maps: 1) United States Army, Corps of Engineers-United States Geological Survey map series, "Western United States, 1:250,000"; 2) United States Geological Survey standard topographic maps, 7½-, 15-, or 30-minute series (topographic mapping of Colorado is incomplete); 3) Rand McNally Commercial Atlas and Marketing Guide, 69th edition, 1938; 4) map, "Life Zones of Colorado" (frontispiece *in* Cary, 1911). Localities not mapped in one of the above-mentioned four sources are identified in brackets in text, using the notation of section-township-range wherever possible. In those cases where I have been unable to locate precisely a given locality of record, that fact is noted parenthetically.

In general, localities of record are listed as they appear on specimen labels or in the literature; qualifying remarks are inserted in brackets where I consider them to be significant or useful. Slight and judicious abbreviations of localities are made *passim* without comment, as are minor emendations to standardize orthography. A convention that I have followed consistently is to cite distance north or south of a point of reference prior to distance east or west.

In no case have I combined nearby localities. In some cases, such as localities labelled with reference to Fort Collins, Boulder, Colorado Springs, or other intensively worked areas, this may appear to be "hair-splitting," or nonsense, or both. The practice is dictated by compelling reasons. When utilizing specimens collected by different persons, many of them novices, a statement as seemingly simple as "3 mi. W Fort Collins," or "4 mi. WNW Boulder," may be highly ambiguous. One has really only a rather general notion of where the collector was unless he knows certainly that the collector had been trained to label specimens with distances from a post office, courthouse, or other such conventional point. Thus, to combine localities of specimens into a statement such as "1 to 3 mi. W Fort Collins," or "within 5 mi. of Boulder," might be wholly misleading. Each record is allowed to stand for itself, and has greater or lesser significance dependent on the care of the collector. In instances where a locality is questionable or a distance seems to me to be in error, the opinion is noted in brackets. For useful comments on ambiguity in locality data, see Anderson (1965).

Ambiguity is particularly important along the eastern flank of the mountains (that area, incidentally, where mammalogical collecting has been most intensive). Great ecological change occurs over short linear distances in such areas. Within a few yards in a canyon in the foothills, one can traverse an "ecological distance" comparable to many miles on the plains to the east. This rapidity of environmental change in Colorado is the second reason for not combining localities.

In certain cases, specimen labels are found to bear equivocal locality data. This is particularly common in Colorado (and elsewhere in the West) where there is an abundance of nameable natural features and an apparent shortage of suitable names. Homonymy is frequent and confusion is a typical result. Some examples will illustrate this point. In Routt County, there are two "Sand Mountains" within 15 miles of each other, and two "Round Mountains" nine miles apart. Perhaps this particular case is unimportant. However, there also is a "Round Mountain" in Gunnison County, some 175 air miles to the south. Unless one knows the habits of a given collector or has access to his field notes, specimens labelled only "Baldy Mountain," "Sand Creek," or "Lost Lake," are virtually worthless for documentation. Such cases have been dealt with individually. Where reasonable doubt surrounds the geographic source of a specimen, that doubt is noted.

Following the locality, the number of specimens examined is noted. Museums in which specimens examined are housed are designated as follows: ANSP, Academy of Natural Sciences, Philadelphia; ASC, Adams State College; AMNH, American Museum of Natural History; CM, Carnegie Museum; CNM, Colorado National Monument; CSC, Colorado State College (now University of Northern Colorado); CSU, Colorado State University; CU, University of Colorado Museum; DMNH, Denver Museum of Natural History; FMNH, Field Museum of Natural History; FHSC, Fort Hays Kansas State College; FLC, Fort Lewis College; FWS, Bureau of Sport Fisheries and Wildlife, Denver Food Habits Collection; GSDNM, Great Sand Dunes National Monument; KU, Museum of Natural History, University of Kansas; MCZ, Museum of Comparative Zoology, Harvard University; MVZ, Museum of Vertebrate Zoology, University of California, Berkeley; NMSU, New Mexico State University; RMNP, Rocky Mountain National Park; SC, collection of D. A. Spencer; SCSC, Southern Colorado State College; TCWC, Texas Cooperative Wildlife Collection, Texas A and M University; UI, Museum of Natural History, University of Illinois; UK, Department of Zoology, University of Kentucky; UNM, Museum of Southwestern Biology, University of New Mexico; USNM, United States National Museum; UU, University of Utah; WC, collection of E. R. Warren; WSC, Western State College of Colorado.

The collections of E. R. Warren and D. A. Spencer both are housed in the University of Colorado Museum, Boulder. They are listed separately, however, for neither had been completely catalogued in the museum when I first began to study there.

Additional records include reports from the mammalogical literature and to a lesser extent from unpublished sources. All references known to me to specimens I did not examine are included. In general, the earliest reference to a given specimen is cited. However, when such citation might lead to nomenclatorial confusion, a more recent reference is cited. Sight records are included only when they fill an appreciable gap in the known range of a species, or significantly extend the range ecologically or geographically. Subspecific assignment of observational records is almost exclusively on geographic grounds. Similarly, additional records from the literature are assigned to subspecies after zoogeographic consideration, generally without comment. When the subspecific assignment herein differs from that cited by an author, that change is noted.

Between general accounts of species and lists of additional records, I have made a conscious effort to cite all primary mammalogical literature directly relevant to Colorado that has come to my attention through December 1970. Literature in fields peripheral to systematic mammalogy is cited less exhaustively. Historical literature has been consulted to gain an appreciation of abundance and distribution of conspicuous mammals in past times. Such literature generally is not cited except where records are marginal or otherwise of mammalogical importance.

Localities of record are plotted on distribution maps. In general, localities nearer to one another than about seven miles could not be plotted without undue crowding of symbols, and localities not plotted are italicized in lists of records of occurrence. Type localities of recognized taxa are designated by triangles. Precise localities of record other than type localities are indicated by circles. Closed symbols denote specimens examined, and open symbols indicate additional records. Records with no specific locality within a county, designated by squares, are plotted only when records are not available from precise localities within a given county.

The outline map indicates boundaries of counties and courses of some rivers. Those rivers shown serve as an aid to orientation and are not exhaustive of the major drainage features of the state. Major streams are shown in figure 5. Names of counties are indicated in figure 1. Topographic features to which reference is made in text without comment are identified on the index map, figure 4.

Specimens Available for Study

The 121 species of native Coloradan mammals are represented in lists of specimens examined by approximately 23,400 specimens (as of October 1970). Thirty-two species each account for one per cent or more of the total number of specimens examined; together these species comprise slightly over 78 per cent of Coloradan mammals available for study in collections. In descending order of abundance in collections, the 32 species are:

Peromyscus maniculatus
Eutamias minimus
Thomomys talpoides
Dipodomys ordii
Spermophilus lateralis
Microtus longicaudus
Microtus pennsylvanicus
Ochotona princeps
Eutamias quadrivittatus
Tamiasciurus hudsonicus
Microtus montanus
Neotoma cinerea
Sylvilagus audubonii
Reithrodontomys megalotis
Microtus ochrogaster
Zapus princeps
Onychomys leucogaster
Geomys bursarius
Thomomys bottae
Sorex vagrans
Canis latrans
Neotoma mexicana
Clethrionomys gapperi
Spermophilus tridecemlineatus
Marmota flaviventris
Spermophilus richardsonii
Cynomys gunnisoni
Cynomys ludovicianus
Peromyscus truei
Cynomys leucurus
Peromyscus difficilis
Ondatra zibethicus

The occurrence of any given species in the foregoing list is a function of a variable number of synergistic factors. *Peromyscus maniculatus* is an abundant and ubiquitous mammal and is readily trapped. Not surprisingly, nearly 16 per cent of all specimens examined were of that species. *Eutamias minimus* has a less extensive range in Colorado than does *P. maniculatus*, but it is widespread and abundant in those parts of the state that have been most thoroughly collected. A further factor that contributes to the high proportion (8.4 per cent) of specimens of *E. minimus* in collections is that the species and its congeners have been the subject of intensive taxonomic studies. The large number of pocket gophers and prairie dogs available reflects the ecological and taxonomic interest of those groups. Other things being equal (which, of course, is never the case), common mammals are better represented than rare kinds, small mammals better than large, widespread species better than those with more restricted

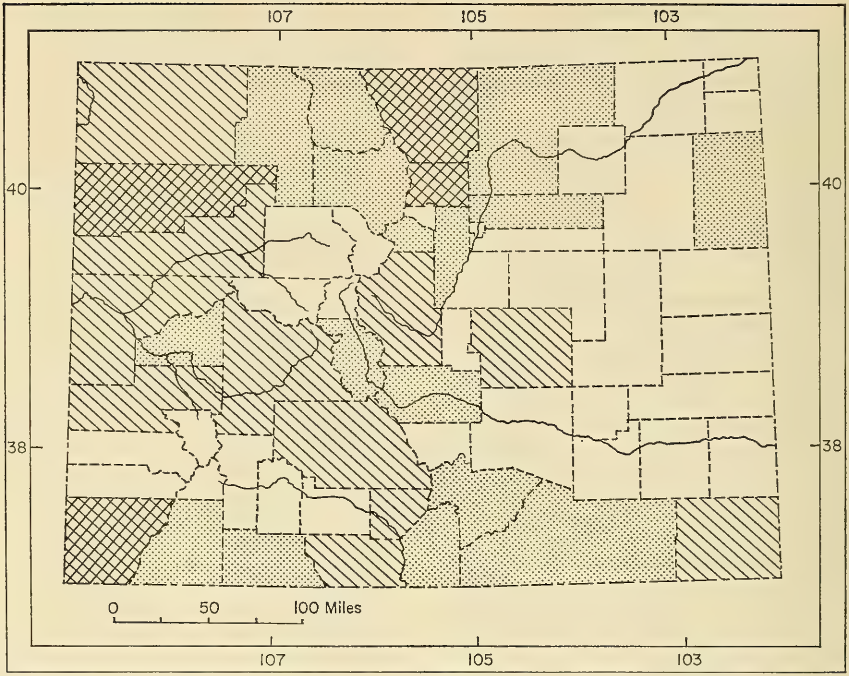


FIG. 2. Percentage distribution of specimens examined by county. Legend: 4 per cent or greater, cross-hatched; 2-4 per cent, diagonal lines; 1-2 per cent, stippled; less than 1 per cent, unshaded.

ranges, and montane mammals better than campestrian taxa. Other factors, such as location of a center of abundance relative to a concentration of collectors, augment the differential representation of species in collections. *Peromyscus difficilis* is fairly abundant immediately west of Fort Collins, for example, and is rather well represented in collections, whereas *Peromyscus crinitus* is abundant in western Moffat County, but few collections have been made there. As a result, the canyon mouse is far less well represented in collections than is the rock mouse.

The approximate percentage of the total number of specimens I examined that were collected in a given county is given in figure 2. Obviously, the distribution of collectors has been far from random. Some specimens have been examined from each county in Colorado, but absolute numbers range from two (Phillips County) to 3763 (Larimer County). Five counties (Larimer, Boulder, Rio Blanco, Gunnison, and Montezuma) account for about 35 per cent of all specimens examined. The wide variation in numbers of specimens available per county is almost entirely attributable to the distribution of collecting efforts.

Within a given county, distribution of localities tends to be highly contagious. For that reason, to adjust numbers of specimens available to the absolute size of a county is not necessarily meaningful. Regardless of the size of a county, specimens tend to be from a relatively small number of localities. Larimer County is the source of nearly one-seventh of all specimens examined, but the great majority of specimens from that county are from within a few miles of Fort Collins, Estes Park, or Loveland. The area north of the Cache la Poudre River and west of the Colorado Piedmont (particularly the Laramie River drainage) has been worked relatively little. Most specimens from Gunnison County are from the vicinity of Gothic and Crested Butte, or from the Gunnison River Valley westward from Gunnison. The bulk of specimens from Montezuma County is from south of a line along McElmo Creek eastward through Cortez to Mancos.

Obviously, those counties that are best known are generally those in which major educational institutions and recreational areas are located. Student collectors from Colorado State University have accumulated material that allows detailed knowledge of distribution within a radius of about 10 miles of Fort Collins. The Colorado State University Forestry Summer Camp at Pingree Park, lower elevations in Rocky Mountain National Park, and Estes Park all have been surveyed intensively. In Boulder County, the vicinity of Boulder is known in some detail, but a preponderance of collectors have worked at higher elevations in the Front Range, particularly about Science Lodge, a research facility of the University of Colorado between Ward and Nederland.

Until the Curecanti Reservoir Basin Surveys were undertaken by the University of Utah, most specimens from Gunnison County were from the vicinity of Gothic, location of the Rocky Mountain Biological Laboratory, and from nearby Crested Butte, site of early efforts on the part of E. R. Warren.

Montezuma County is among the five counties best represented in mammalogical collections mostly because of the extensive work in Mesa Verde National Park by representatives of the Museum of Natural History of the University of Kansas. Rio Blanco County is alone among the five in having no major educational institution or national park. Major collections were made there in the late 1930's and early 1940's by J. K. Doutt and colleagues from the Carnegie Museum, and by the late G. G. Goodwin and a field party from the American Museum of Natural History. Earlier, incidental collections were made there by a great many persons, including Ernest Thompson-Seton and Theodore Roosevelt.

In general, counties accounting for more than one per cent of specimens examined have been visited by a field party of one or more major museums or by the Bureau of Biological Surveys. Counties accounting for less than one per cent of the total have been the object of only brief or localized collecting efforts, in some instances (for example, Kit Carson, Custer, Bent, Hinsdale, Mineral counties) primarily by me.

It is readily apparent from figure 2 that the area most poorly represented in Colorado is the eastern plains. However, patterns of distribution there are generally understood. Certain poorly surveyed parts of the western two-thirds of the state appear to me to be more significant from the standpoint of zoogeography. Western Las Animas County—the Park Plateau and Culebra Range—is such an area. The floor of the Wet Mountain Valley is another, and the lower mountains of Eagle and Pitkin counties are important and poorly represented in collections. In the southwestern part of the state, the Dolores River watershed above Paradox Valley may well hold answers to as yet unasked questions. Although general reconnaissance is indicated in a few circumscribed areas, detailed studies of ecological distribution are needed in most major habitat-types in Colorado.

The foregoing brief remarks should dispel any notion that abundance of specimens examined is a direct and necessary correlate of abundance in nature. The bias of differential abundance of specimens and that caused by the inequality of effort from a geographic standpoint (see Fig. 2) must affect the merit of individual accounts of species and the overall merit of analytic and synthetic aspects of this study. However, I suspect that the bias generally is less important than is immediately apparent. For present purposes, areas such as Larimer and Boulder counties and species such as *Peromyscus maniculatus* and *Eutamias minimus* are known in excessive detail. Other areas (the southern San Luis Valley, for example) and species (*Thomomys bottae* and *Dipodomys ordii*, for example) appear to be poorly known in comparison, but are, in fact, understood in detail wholly suitable to the kinds of analytic methods employed beyond.

Some species of bats, certain insectivores, and some kinds of pocket mice have been studied in too little detail in Colorado to make meaningful statements about areal or ecogeographic distribution. Distributional patterns of such species as indicated beyond are at best educated guesses, and, like all other extrapolations from limited observation, subject to revision in the light of new information.

ENVIRONMENT OF COLORADO

PHYSIOGRAPHY

The dominant physiographic feature of Colorado is the series of high, north-south mountain ranges occupying the central part of the state. Historically, the mountains have dictated to a considerable extent the evolution of the landscape elsewhere in Colorado. Literature on evolution of the modern features has been summarized by King (1959).

The present landscape of Colorado has developed over a long span of geologic time under the influence of the Cordilleran Orogeny, the episode of mountain-building that shaped the character of much of western North America. The eastern cordillera, or Rocky Mountains, developed in later Mesozoic and Tertiary times, later than initial phases of orogeny in the western cordillera. During the Tertiary and Quaternary periods, the primary uplift attained its present form through further crustal mobility, volcanism, erosion, and sedimentation. The eastern cordillera appears to be attaining stability.

The orogenic phase of the Cordilleran Orogeny—the so-called Laramide Revolution—took place in latest Cretaceous and Paleocene times. A post-orogenic phase followed in which crustal movement continued. Faults developed and volcanism was pronounced and widespread. Volcanism was at its zenith in the San Juan region during the Miocene, but continued into Pleistocene time. In addition to crustal movement, there was regional uplift of the entire mountain system, the Colorado Plateaus to the west and the Great Plains to the east. This uplift changed a region of low relief, low elevation, and warm climate into an area of high elevations and marked relief, with a greatly modified, generally arid, climatic regime. It is not known whether uplift and accompanying changes were episodic, with alternate periods of quiescence, or a slow but continuous rise since the Laramide Orogeny.

Erosion and sedimentation during the Tertiary Period altered the form of the developing mountains and spread an alluvial mantle over the eastern plains. The transformation of the Tertiary landscape into the modern one is an on-going event begun during the Pleistocene Epoch, when increased precipitation began a cycle of accelerated erosion, which degraded and dissected the region. The extent to which the physiography of Colorado is tied to the Southern Rocky Mountains should become evident from descriptions of physiographic provinces beyond.

Fenneman (1931) recognized three major physiographic divisions in Colorado, listed below along with their subdivisions in the state:

- Interior Plains Division
  - Great Plains Province
    - High Plains Section
    - Colorado Piedmont Section
    - Raton Section
- Rocky Mountain Division
  - Southern Rocky Mountain Province
  - Middle Rocky Mountain Province
  - Wyoming Basin Province
- Intermontane Plateaus Division
  - Colorado Plateaus Province
    - Uinta Basin Section
    - Canyonlands Section
    - Navajo Section

Boundaries of these principal physiographic units are mapped in figure 3, and each is described in more or less detail below, the discussions based largely on Fenneman (1931) and Thornbury (1965). Elevations of mountain peaks follow Ormes (1955). Some of the features discussed beyond are located on the index map of Colorado (Fig. 4).

Great Plains Province

High Plains.—Erosion and sedimentation during and after the Laramide Orogeny formed a thick alluvial mantle that originally reached from the mountains to the central lowlands of the continent. The mantle was laid down largely by braided streams as floodplain alluvium. The fluviatile origin of the High Plains is seen in the character of the sediments, largely unconsolidated silts with some sand- or gravel-sized particles. Locally these may be cemented into resistant calcareous "mortar beds" that form ledges, cliffs, and mesas. Beneath the mantle, the most

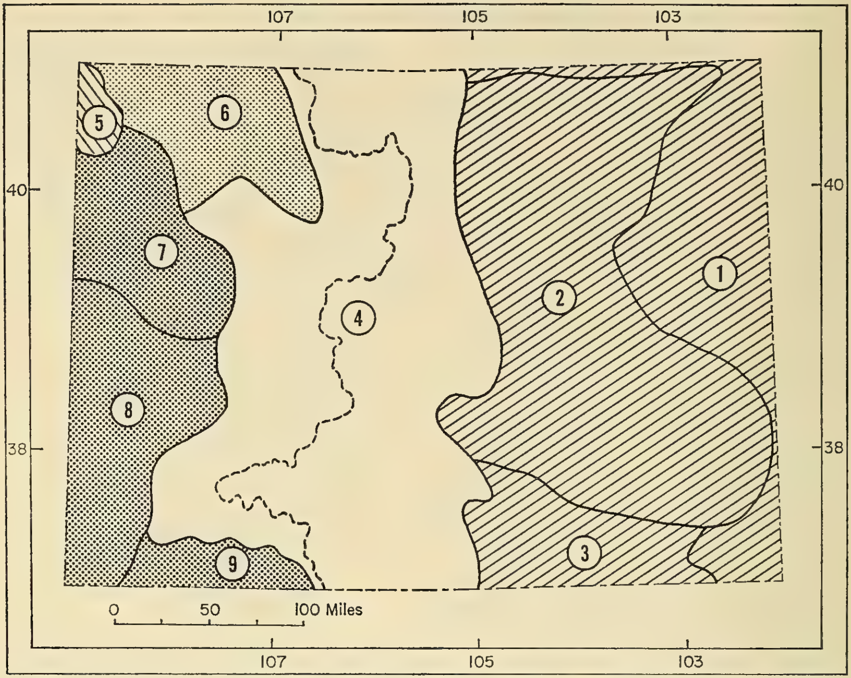


FIG. 3. Physiographic subdivisions of Colorado (after Fenneman, 1931). Great Plains Province: 1, High Plains Section; 2, Colorado Piedmont Section; 3, Raton Section. Rocky Mountain Division: 4, Southern Rocky Mountain Province; 5, Middle Rocky Mountain Province; 6, Wyoming Basin Province. Colorado Plateaus Province: 7, Uinta Basin Section; 8, Canyonlands Section; 9, Navajo Section.

common rock is shale, and where streams have removed the mantle, springs and seepage are common. Superimposed on the Tertiary mantle of the High Plains are eolian deposits of sorted Tertiary sediments and deposits of Pleistocene age, including loess, dune sand, gravels and ash.

In general, the topography of the High Plains is monotonously flat, with noticeable relief only along watercourses. Occasional areas of dune sand, and blow-outs and "buffalo wallows" lend some character to the region.

Colorado Piedmont.—Between the typical High Plains and the Rocky Mountains, the Tertiary mantle has been largely removed and the older strata beneath more or less eroded. On the divide between the South Platte and Arkansas rivers, erosion has been less complete, but a distinct section, the Colorado Piedmont, is nonetheless readily definable.

The most common rock of the piedmont is shale. In the Arkansas Valley, shales are interbedded with limestone; over large areas near the Arkansas River, the Niobrara formation appears at the surface, upholding lines of limestone hills or low ridges. Shales are interbedded with sandstone in the South Platte Valley. The sandstones may have a topographic effect similar to that of the limestones to the south, but usually it is not so marked.

In parts of the Arkansas drainage, the Ter-

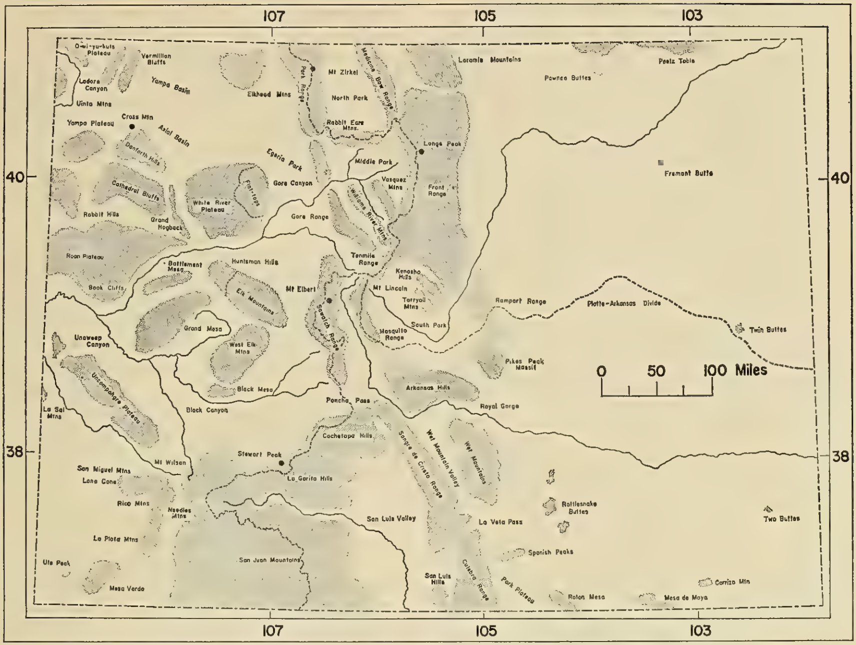


FIG. 4. Index map of Colorado, locating principal physiographic features discussed in text.

tiary mantle has not been completely removed, but has been sorted and deposited as dune sand. Further character is given to much of the western part of the piedmont by Quaternary alluvium.

The Platte-Arkansas Divide may never have been covered by the Tertiary mantle characteristic of the plains. It was, however, covered by an earlier mantle, derived from the Ancestral Rocky Mountains, and seen today as a resistant conglomerate. These rocks give the western end of the divide strong relief and affect the groundwater regime. Ecologically the area is related closely to the foothills and lower mountains, but is nonetheless a part of the Great Plains Province.

Raton Section.—At the foot of the mountains, all sedimentary units dip steeply eastward, forming a great trough, the so-called "Denver Basin." The western wall of the basin is marked by hogbacks in the Dakota, Lyons, and Fountain sandstones and other sedimentary formations. South of Pueblo an upward fold extends southeastward, bringing the sandstones back to the surface. The exposed crest of that fold defines the Raton Section. The Raton Section merges gradually with the Colorado Piedmont in some localities, but generally is higher and more complex, hence distinctive. Characteristic topographic features include mesas, cuestas, dissected plateaus, deep canyons, and volcanic features of various ages.

Basaltic rocks cap Raton Mesa (the western terminus of which is Fisher's Peak, 9586 feet) and Mesa de Maya. Locally the cap reaches a thickness of some 500 feet. The elevation of the groups of mesas declines eastward with the volcanic cap, reaching the general level of the plains at about the 103rd

Meridian. The Park Plateau, northwest of Raton Mesa, is not volcanic, but is formed mostly of resistant sandstones. The spectacular Spanish Peaks to the north are of volcanic origin. Many long dikes extend from the stocks well out into the surrounding lowlands, impeding erosion. While closely related ecologically to the nearby Sangre de Cristo Mountains, the Spanish Peaks, like the Park Plateau and the high mesas of the Raton Section, historically and physiographically are part of the Great Plains Province.

Southern Rocky Mountains Province

Major ranges of the Southern Rocky Mountains are indicated in Fig. 4. Colorado is crossed by two great parallel granitic belts, separated for much of their length by structural depressions. Each of these belts is flanked by subordinate ranges. In general the ranges are broad, elevated granitic masses with a north-south orientation, flanked by steeply inclined sedimentary units; the latter usually are seen in homoclinal foothills, but locally may cap summits. In general the granitic mass has been dissected into mountainous terrain, but in South Park it remains a plateau at an elevation of more than 9,000 feet. Locally, volcanic activity has formed mountains and altered granitic massifs; the San Juan Mountains are almost entirely volcanic. On individual peaks, older erosional and volcanic topography has been largely obscured or obliterated by Quaternary glacial erosion, leaving typical arêtes, cirques, and glacial valleys.

The eastern granitic belt forms the Front Range and several lesser ranges, frequently referred to together as "front ranges." The Front Range proper extends from the Arkansas River northward to the Cache la Poudre River, where the range divides into the eastern Laramie Mountains and the western Medicine Bow Mountains, with the semi-arid Laramie River Valley between them. The Laramie Mountains are low, but the Medicine Bow and Front ranges have much alpine area, well dissected into spectacular relief. Some of the most rugged areas are preserved in Rocky Mountain National Park. In the vicinity of Georgetown, the general north-south trend of the granitic belts is disturbed and lesser, local ranges have been named. Northwest of Georgetown are the Williams River and Vasquez mountains; to the southeast are the Kenosha Hills and Tarryall Mountains, which trend toward the Rampart Range (that sector of the Front Range south of the South Platte River) and Pikes Peak.

South of the Arkansas River lie the Wet Mountains and the Sangre de Cristo Range, the latter an eastward extension of the western granitic corridor. The trough between the two ranges is the Wet Mountain Valley. The Sangre de Cristo Range is flanked with sedimentary formations that still overarch the granitic core in places. Glacial features are abundant, particularly north of La Veta Pass.

The western chain of mountains enters the state from Wyoming as the Park Range. The belt trends southeastward from the Colorado River as the Gore Range, and again trends southward from Tenmile Creek as the Mosquito Range. West of North Park the Park Range is a strongly glaciated alpine ridge, marked by Mount Zirkel (12,200 feet). Farther south the ranger is more plateau-like, declining gently westward. The Gore Range, trending southward from Rabbit Ears Pass, is lofty and serrated by glacial erosion. The Mosquito Range also is greatly eroded. The latter range forms the western boundary of South Park and meets the Continental Divide at Mount Lincoln (14,284 feet) above Fairplay.

The Sawatch Range is a great anticline paralleling the Gore and Mosquito ranges. The Sawatch boasts the four highest peaks in Colorado—Mount Elbert, Mount Harvard, Mount Massive, and La Plata Peak, all more than 14,300 feet in elevation—and 15 of the 54 Coloradan peaks of 14,000 feet or higher.

To the west of the granitic belt of the Park and Sawatch ranges are east-west oriented lobes of mountains that merit special mention. The White River Plateau is similar in structure to the Uinta Mountains to the northwest —it is a dome, steep-sided, but nearly flat on top. The dome retains a thick sedimentary cap. Although this basic structure is a common one in the region, it is particularly well preserved on the White River uplift. To the west of the plateau, the Grand Hogback marks the boundary of the Colorado Plateaus Province.

The Elk Mountains parallel the White River Plateau on the south. The northwestern terminus of the range is the Huntsman Hills. On the southeast, the Elk Range abuts the Sawatch Range. The Elk Mountains are not extensive, but contain six peaks above 14,000 feet in elevation and a wealth of spectacular alpine features of glacial origin.

The West Elk Mountains lie to the south of the Elk Mountains and west of the principal granitic axes. Most of the mountains are laccoliths—bedrock overarching lenticular intrusive igneous bodies—but the range also includes peaks eroded from extrusive formations that are related historically to the San Juan Mountains. The West Elk Mountains are bounded on the south and east by the Gunnison River, which is actively incising the lava and tuffs, flowing through the 3000-foot deep Black Canyon as it enters the Colorado Plateaus Province.

The San Juan region includes that area of volcanic mountains and hills lying south of the Gunnison River and west of the San Luis Valley. The San Juan Mountains *sensu stricto*, carved from sheets of lava and tuffs, are the high ranges of the western part of the area. Three volcanic episodes with alternate erosional cycles formed the general topography, but glaciation added detail.

North of the San Juans a structural dome exposes the pre-Cambrian core of the region. This is the Needle Mountain Uplift. Dut to the nature of the rock, largely quartzite, glacial erosion has carved spectacular peaks with precipitous slopes. The San Miguel Mountains, including Mount Wilson (14,246 feet), are related structurally to the San Juan Mountains, from which they have been isolated by erosion. The nearby Rico and La Plata mountains are well-dissected domal uplifts of independent origin.

The San Juan region extends well to the east to bound the San Luis Valley. The region is a dissected plateau of lava, ranging in elevation to about 11,000 feet. Included in the region are important divides, such as the La Garita and Cochetopa hills, and isolated high peaks, including San Luis Peak (14,014 feet) and Stewart Peak (14,037 feet).

In local usage, the term "park" refers to any inter-mountain depression that is devoid of forest or extensive woodland—hence, Taylor Park, Estes Park, Saguache Park. Among the mountain parks of Colorado, three—North, Middle, and South parks—are of particular interest; together with the Wet Mountain Valley, they occupy the trough between the principal north-south granitic belts.

North and Middle parks occupy a single structural basin and are separated only by the volcanic Rabbit Ears Range, generally unimpressive mountains, but a major drainage divide, separating the headwaters of the North Platte and Colorado rivers. North Park is bounded on the north by the Medicine Bow and Park ranges, which converge near the Colorado-Wyoming boundary. The park is an area of slightly rolling, sagebrush-covered hills, with a mean elevation above 8000 feet. The many streams from the surrounding mountains are the headwaters of the North Platte River, which leaves the park through the north wall of the basin.

Middle Park contrasts with North and South parks in the presence of hills on the east and south and in the development of volcanic mesas and buttes. The floor of the park is highly dissected. The Colorado River heads above Middle Park and cuts through the Gore Range in Gore Canyon.

South Park is a large depression formed by the Laramie Uplift. Erosion of the surrounding upland spread detritus over the floor. This layer generally remains undissected, and South Park is a basin primarily because it is largely surrounded by monadnock ridges. Because the peneplained surface remains intact, the elevation of the floor of the park is more than 9,000 feet. The basin is well defined on the west by the Mosquito Range and on the north by the Kenosha Hills and Tarryall Mountains, but the southern and eastern limits of the park are indefinite. A generally similar landscape exists east to the Pikes Peak area and southward to the Arkansas Valley. It is best to restrict the term "South Park" to that area drained by the South Platte River. The drainage of the Arkansas River immediately to the south and west is essentially similar to South Park proper. For discussion of the geomorphic history of South Park, see Stark *et al.* (1949).

The San Luis Valley lies between the Sangre de Cristo Range and the San Juan massif. It is not generally considered to be a mountain park, but its relations to surrounding ranges are comparable. The northern end of the valley is marked by the merger of the Sangre de Cristo and Sawatch ranges at Poncha Pass. The valley continues into New Mexico with the Rio Grande, but near the state boundary the character of the landscape changes markedly. The low, volcanic San Luis Hills once dammed the Rio Grande there and alternate layers of sand and clays filled the basin. On the Taos Plateau of New Mexico these lacustrine deposits are not evident. Upson (1939) recognized five physiographic subdivisions in the San Luis Valley.

The San Luis Valley is an orographic desert and the paucity of precipitation is reflected in the xerophilic vegetation and gray desert soils. However, the nature of the sediments flooring the valley is such that water percolates freely from the through-flowing Rio Grande and from the internal drainage basin of Saguache and San Luis creeks. This water surfaces locally as springs and shallow lakes, and by artificial removal the resource has been utilized for irrigation to build a productive agricultural economy.

Middle Rocky Mountains Province

The Uinta Mountains lie largely in northeastern Utah, but the eastern end of the uplift is in northwestern Colorado. The Uinta Mountains are unique among major North American mountain ranges in their east-west orientation. The initial uplift was extensive, but much of the material has been stripped away. A seeming anomaly is the course of the Green River through the range in a winding canyon some 2000 feet deep. Along its short course in Colorado, the Green River receives the Yampa River, the master stream of the northwestern part of the state, which has cut a canyon nearly as impressive as that of the Green through the pre-Cambrian quartzites of the uplift, having established a meandering course on softer sediments above.

The Uinta Range is related structurally to the White River Plateau, but the intervening region, save for isolated mountains and the Danforth Hills, belongs to the Wyoming Basin both historically and ecologically.

Wyoming Basin Province

The Yampa Basin, lying north of the Yampa River, is an area marked by broad areas of little relief separated by eroded scarps and cuestas. Principal streams are the Little Snake and Yampa (or Bear) rivers. The Yampa Basin is essentially continuous with the Washakie Basin of southern Wyoming. The entire Wyoming Basin communicates broadly with the Great Plains through central Wyoming, and to a lesser degree with North Park in the Northgate area. South of the Yampa Basin are the smaller Axial Basin and the Danforth Hills. The latter feature was mentioned above as a structural link between the White River Plateau and the Uinta Mountains. Juniper Mountain and Cross Mountain stand in a similar relationship between the two major uplifts.

The only remnants of volcanic activity in the Coloradan sector of the Wyoming Basin are the Elkhead Mountains, which abut the Park Range in Routt County. These are flat-topped sedimentary mountains capped with resistant basalts, allowing elevations some 2000 to 3000 feet above the surrounding country.

Colorado Plateaus Province

In contrast to adjacent provinces, strata of the Colorado Plateaus are essentially horizontal. Topography is almost entirely a function of the dissection of these horizontal beds. In general, the aspect of the province is that of a land of canyons, the formation of which has been favored by the elevation of the plateau above its base level, the intrinsic strength of the beds (which dictates slow wasting and allows steep slopes), and the mountain border to the east which furnishes orographic precipitation to through-flowing streams.

Uinta Basin.—This section in Colorado may be thought of as the region of the Book Plateau, bounded on the east by the Grand Hogback and on the north and south by the White and Colorado rivers, respectively. A descent of some 3000 feet from the Book Plateau to the general level of eastern Utah is made in two steps, the northern one known as the Roan Cliffs and the southern as the Book Cliffs. Eastward in Colorado, the two lines of cliffs merge gradually.

The Colorado River flows generally south of the Uinta Basin Section, but in the eastern end of the section it turns northward to isolate Grand and Battlement mesas. These extensive features are capped with lava and are some 10,000 feet in elevation.

Canyonlands Section.—This area is bounded on the north by the Colorado River and on the east by the Elk Mountains and the ranges of the San Juan region. On the south, the section merges into the desert of the Navajo Section. The Canyonlands Section has been shaped by streams from the east—the Gunnison, Uncompahgre, Dolores, and San Miguel rivers. In Colorado, in sharp contrast to eastern Utah, the rivers have broad valleys and floodplains on the weak rock. The San Miguel and Gunnison-Uncompahgre rivers bound the Uncompahgre Plateau, a structural uplift reaching well above 9000 feet and providing marked ecological contrast with surrounding areas. The northwestern end of the plateau is cut off from the remainder by Unaweep Canyon, an impressive gorge marking the course of an ancestral Colorado River (see Lohman, 1961).

South of the Dolores River, Mesa Verde rises 2000 feet above the surrounding region, reaching an elevation of more than 8500 feet at Park Point.

Navajo Section.—The region south of Mesa Verde and the San Juan Mountains, drained by the San Juan River, is distinguished as part of the Navajo Section. Beds of sandstone and shale dip slightly and have been eroded into cuestas and cut by arroyos under the influence of a distinctly arid climate. North of Mesa Verde and west of the San Juans is the so-called "Great Sage Plain," somewhat dissected, but dominated by the resistant Dakota sandstone, hence generally nearly level. Ute Peak, west of Mesa Verde, is a laccolith, as are the La Sal Mountains on the Colorado-Utah boundary.

Summary

The mountains of central and western Colorado have been of profound importance to the physical evolution of the rest of the state. Erosion of the mountainous core has contributed material for an alluvial mantle to the east, removed over much of the Colorado Piedmont, but largely undisturbed on the High Plains.

To the western plateaus, the mountains have furnished through-flowing streams that have carved an area of typically horizontal sedimentary beds into deep canyons and prominent mesas and cuestas. Large areas of upland—Grand and Battlement mesas, the Uncompahgre Plateau, Mesa Verde—remain as ecological extensions of the mountains into an otherwise semiarid region.

In the southeastern part of the state, volcanic activity has produced highlands, including the Spanish Peaks, Raton Mesa, and Mesa de Maya, which extend the ecological regime of the mountains into an area that in physiographic terms is an atypical margin of the Great Plains.

Northwestern Colorado is a series of structural basins and semi-isolated ranges that have evolved a biotic relationship to the Great Plains through the broad slump in the axis of the cordillera in central Wyoming.

The complex geomorphic history of the area within the political boundaries of Colorado has led to a comparably complex landscape. It is the interplay of that landscape with climatic fluctuation that has given Colorado much of its particular zoogeographic interest.

HYDROGRAPHIC FEATURES

Drainage features are of importance in the distribution of mammals for a variety of reasons. Historically, master streams of a region dictate the evolution of surface features. This in turn affects the distribution of biotic communities and their component species. Streams and their valleys may provide corridors for dispersal or they may constitute barriers, although frequently it is not the physical presence of a stream itself that makes it a formidable barrier or a satisfactory corridor. Streams can be crossed when frozen or during drought, or can change in course, allowing a population access to the far side. More frequently it is the indirect ecological effect of a stream that creates a barrier (or

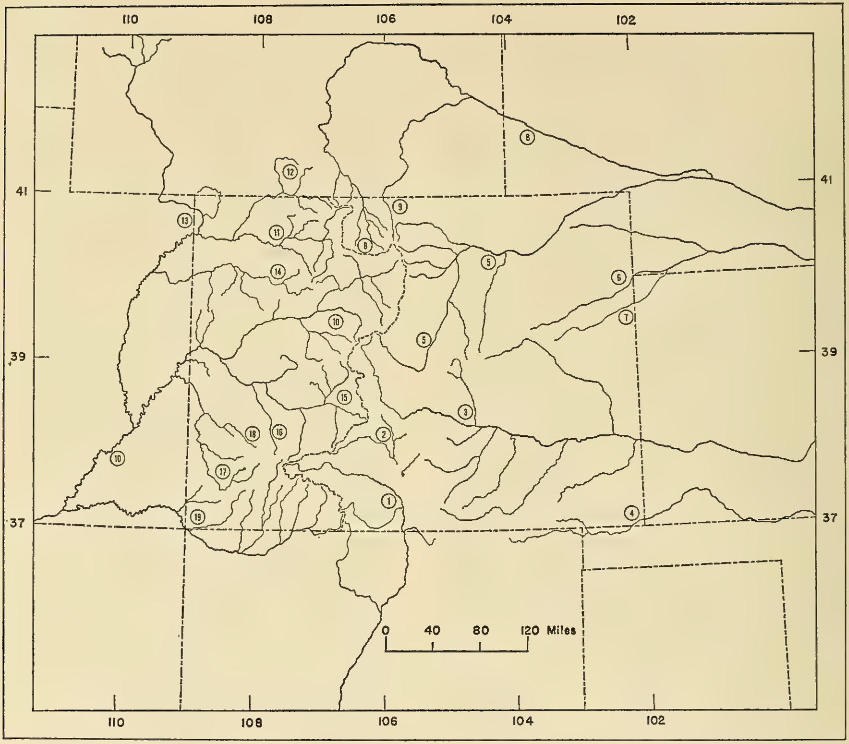


FIG. 5. Map of Colorado and parts of adjacent states showing principal hydrographic features; numbers apply to major watersheds, identified in text. Irregular north-south line in Colorado is the Continental Divide. (Modified from map, "United States of America showing extent of public land surveys. . . ," 1:2,500,000, U.S. Geological Survey and Bureau of Land Management, 1965.)

corridor). Streamside vegetation may be inappropriate as cover or food supply for a given species. Disruption of vegetation by canyons or floodplains may create an impassable barrier of long-term significance.

Major drainage features of Colorado and adjacent areas are indicated in figure 5, and are identified by number in the following text. Four major streams of the western United States head in the mountains of Colorado—the Rio Grande, Arkansas, Platte, and Colorado. The Rio Grande (1) rises in the San Juan Mountains southeast of Silverton, and flows eastward in a broad trough to the San Luis Valley. Turning southward at Alamosa, it flows into New Mexico, having lost much of its flow to the artesian basin suspended beneath the San Luis Valley. Major tributaries in Colorado are Culebra Creek and the Conejos River. The northern part of the San Luis Valley is an internal drainage basin (2), receiving the waters of Saguache, Crestone, and Medano creeks.

The Arkansas River (3) heads in the Sawatch Range above Leadville. The Upper Arkansas flows through a generally narrow valley to the vicinity of Buena Vista, and then occupies a more open trough. The Royal Gorge of the Arkansas cuts through the eastern granitic corridor, separating the Wet Mountains from the Pikes Peak massif. Major tributaries of the Arkansas from the south are the St. Charles, Huerfano, Cucharas, Apishapa, and Purgatoire (or "Picketwire") rivers, and Two Buttes Creek. Fountain Creek and Big Sandy Creek are important affluents from the north. The point where the Arkansas River leaves Colorado is the lowest in the state (3350 feet).

The Cimarron River (4) barely enters the southeastern corner of Colorado, its tributaries draining southern Baca County and the Mesa de Maya area.

The South Platte River (5) takes its origin in South Park. Important tributaries are Clear Creek, Boulder Creek, and the St. Vrain, Big Thompson, and Cache la Poudre rivers, all originating in the Front Range. Tributaries heading on the plains, principal among which are Cherry Creek and Bijou Creek, typically are ephemeral. Affluents entering the South Platte from the north are short, heading on the Peetz Table and other uplands along the break of the High Plains, a feature generally coincident with the Wyoming boundary. East-central Colorado is drained by the Arikaree (6) and Republican (7) rivers.

The North Platte River (8) arises in the mountains above North Park. Numerous streams follow meandering courses through the park, but coalesce near Cowdrey and leave the state as a single stream. The Laramie River (9), confluent with the North Platte below Guernsey, Wyoming, originates in western Larimer County.

The Western Slope ultimately drains into the Colorado River (10), but in Colorado, several major contributory streams are worthy of mention. The Yampa (formerly called Bear) River (11) is the master stream of the northwestern part of the state. The Yampa heads in the extensive parklands around Steamboat Springs. Williams Fork enters the Yampa below Craig (there also is a Williams Fork of the Colorado, and both Williams Forks have had minor mountain ranges named for them, facts that have led to some confusion in locality data). Fortification Creek is another important affluent. The Yampa River receives the Little Snake River (12) at Lily, and enters a spectacular canyon, much of which is preserved in Dinosaur National Monument. North of the town of Dinosaur (formerly called Artesia), the Yampa flows into the Green River (13), which barely loops into Colorado.

The White River (14) originates on the White River Plateau and related uplifts and, receiving the waters of Douglas and Piceance creeks, drains much of the Roan Plateau. The White River flows into the Green at Ouray, Utah.

Below Grand Junction, the Colorado River (10) occupies a broad, semidesert valley, the so-called Grand Valley. Eastward from Grand Junction, a similar valley is occupied by the Gunnison River (15); the Colorado River ("Grand Fork") lies in a narrower trough. The main stem of the Colorado heads in Middle Park, and receives such major tributaries as the Blue River, Eagle River, Williams Fork (see above), and Roaring Fork. The Gunnison River drains a great area of open parklands at its upper reaches, receiving the waters of Cochetopa and Tomichi creeks, the Taylor River, and the Lake Fork, before flowing into the Colorado Plateaus Province through the Black Canyon. At Delta the Gunnison receives the Uncompahgre River (16). Those two streams receive numerous intermittent tributaries from the Uncompahgre Plateau. The southern part of the Uncompahgre Plateau is drained by the Dolores (17) and San Miguel (18) rivers. The Dolores River flows into the Colorado above Moab, Utah.

The extreme southwestern part of Colorado is drained by the San Juan River (19) and its tributaries, the Navajo, Los Piños, Florida, Animas, La Plata, and Mancos rivers. The San Juan follows a tortuous course before joining the Colorado north of Navajo Mountain in south-central Utah.

The Continental Divide follows a sinuous course through Colorado from north to south. The Western Slope encompasses 37 per cent of the area of the state, but yields 69 per cent of the surface water (Waters, 1958:461). To increase the amount of water on the more populous Eastern Slope, ambitious programs of diversion and impoundment of water have been undertaken. Streams heading in Colorado furnish water to much of the southwestern United States for domestic, industrial, and agricultural uses. I doubt that diversion projects have affected mammalian distribution save locally. Impoundment has profound local ecological effects and may mean short-term or even long-term changes in mammalian movements and distribution (see discussion beyond of effects of man on mammalian environments).

SOILS

The character of the soil affects the local and regional distribution of members of the mammalian fauna to various degrees. In the case of fossorial kinds, the relationship of distribution to soil-type may be direct and obligate. The indirect effect of the soil through its influence on vegetation must ultimately affect the distribution of all kinds of mammals.

Soils are the complex result of the interaction of geological parent material, relief, macro- and microclimate, and the biota, over time. The complexity of pedogenesis is reflected in the debate among soil scientists regarding a "natural" classification of kinds of soils. The schemes of classification reviewed by Buckman and Brady (1960) are widely accepted, however, and are useful here.

Based on the relative influence of the several pedogenic factors, soils may be classed as zonal, intrazonal, or azonal. A zonal soil is a "normal" soil, which has a well-developed profile in equilibrium with the physical and biotic environments. An intrazonal soil has a well-developed profile, but shows evidence of the pronounced dominance of either parent material or relief in its pedogenic history. An azonal soil shows little or no profile and represents immature, incompletely weathered material. Each of these pedologic orders is important in the environmental mosaic in Colorado. Zonal and azonal soils occur over wide areas; intrazonal soils, such as soils of bogs, are more restricted in their occurrence, and, although important to local mammalian distribution, are obscured when mapping the great soil groups over a large area.

Zonal soils in Colorado represent the following great soil groups: chestnut soils, brown soils, sierozem (gray desert soils), and brown-gray podzols. Azonal soils of importance include lithosols, regosols, and alluvium. General occurrence of great soil groups in Colorado is shown in figure 6. These kinds of soils are described briefly because they occupy areas of contrasting environmental conditions. The descriptions mostly follow those in *Soils and Men* (Yearbook, U. S. Dept. Agriculture, 1938).

Chestnut soils occur in northeastern Colorado, in North Park, and in parts of extreme western Colorado. They are characterized by a dark, grayish-brown surface grading into pale gray calcareous horizons at one and one-half to two feet. On the plains, the soils have developed from eolian silts and from calcareous Tertiary sediments exposed by erosion, under the influence of a temperate, subhumid climate, and a vegetation of mixed grasses. In North Park and in western Colorado, these soils have developed from sedimentary and metamorphic rocks on alluvial fans and stream terraces.

Brown soils occur over much of the plains region of eastern Colorado and in parts of the San Luis Valley. Surface horizons are brown and grade into pale gray calcareous horizons at one to two feet. These soils have matured under a temperate, subhumid climate. Vegetation consisting of short-grasses, bunchgrasses, and xerophytic shrubs has influenced their development. In southeastern Colorado, brown soils were derived from the calcareous marls of the Ogallala formation. The area was an important source of eolian material in the "Dust Bowl" of the 1930's. Along the mountain front to the north, brown soils have developed from alluvium, but the parent material farther east is unconsolidated wind-borne deposits. For details on soils of eastern Colorado, see Johnstone *et al.* (1962).

Sierozems occur on semidesert plateaus and basins of northwestern Colorado, in the valleys of the Colorado and Gunnison rivers, in extreme southwestern Colorado, and in the central San Luis Valley. Gray desert soils are derived largely from sedimentary rocks, but locally basalts or metamorphic rocks contribute parent material. Colors of the surface vary from gray to red depending on parent materials. Both surface and subsoil are cal-

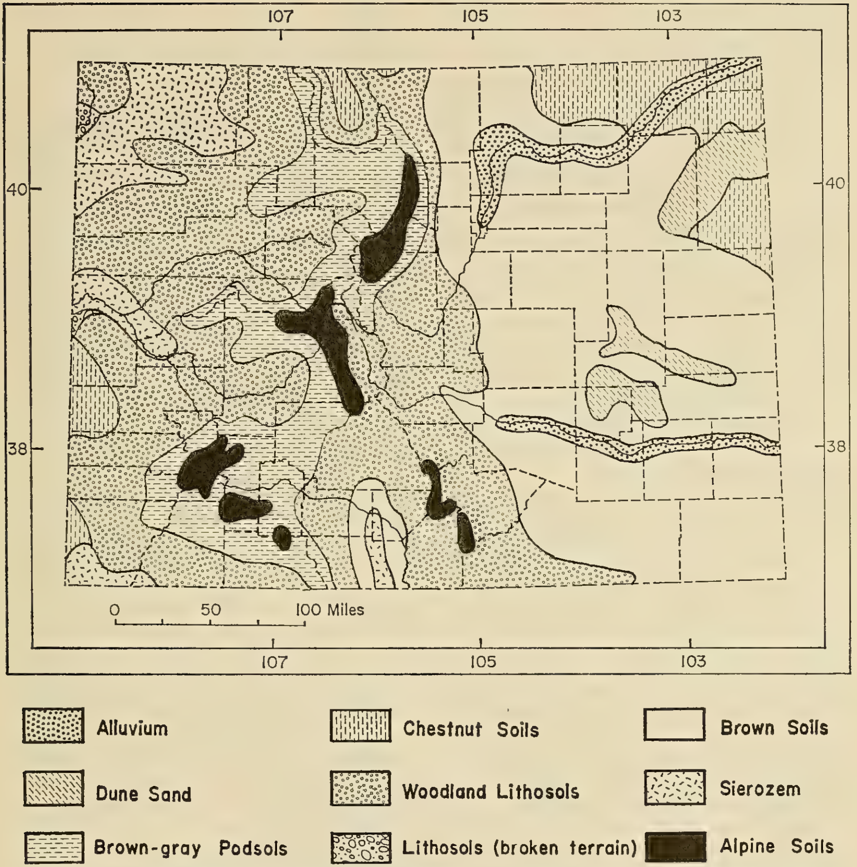


FIG. 6. General distribution in Colorado of Great Soil Groups (modified from map accompanying Soils and Men, Yearbook, U.S. Department of Agriculture, 1938).

careous, in places forming a cemented hardpan of lime or gypsum. Natural vegetation consists of desert shrubs and bunch-grasses.

Brown-gray podzols occur widely in the mountains to elevations slightly above 10,000 feet. The soils have developed largely from metamorphic parent materials under more humid conditions than those in the lithosol zones of both lower and higher elevations. The development of a brown surface horizon has been influenced by coniferous forest, which provides a cover of litter. Both brown-gray podzols and zonal tundra soils (see beyond) are acidic, being relatively high in humus and mostly leached of salts, owing to development under rather humid conditions. In these characteristics, the pedalfers of the mountains stand in contrast to pedocals of lower elevations, where accumulation of carbonates is the rule and the reaction of the soil typically is neutral or basic.

Lithosols are widespread in Colorado and are of several distinct kinds. In western Colorado they occur on rough, eroded canyonlands and frequently are devoid of vegetation, except on alluvial fans or floodplains, or where resistant rock has retarded erosion and stabilized the topography. Lithosols also occur in the foothills of the Eastern Slope, in the Raton Section, and in the mountain parks. These soils have been derived from a variety of parent materials either *in situ* or on talus, fans, or terraces. Vegetation may consist of open stands of sagebrush, shrub associations with undergrowth of bunch-grasses or forbs, or open coniferous woodland. Lithosols are complex soils, varying in structure, depth, color, and texture over short distances. Most are shallow, stony, and without definable profile development.

Soils of the area above tree-line also are largely lithosols. The usual situation is a complex of rather barren, stony ground (fellfield) and alpine meadow. Soils generally are shallow, but high in organic matter; microbial action is slow in the severe climate of high mountains (see Faust and Nimlos, 1968). Soil structure may be good, but except locally there is little development of profile. Where profile does develop, the soil may be considered zonal. Retzer (1956) discussed zonal alpine soils, recognizing three broad classes—alpine turf, alpine meadow, and alpine bog. In figure 6 alpine soils are indicated as lithosols inasmuch as this is the more general case.

Regosols are represented in eastern Colorado by dune sand. Over wide areas the sand has been stabilized by characteristic arenophilous vegetation, but drifting is frequent in natural or culturally-induced "blowouts." The deposits are of eolian origin from Tertiary sandstones. The soils tend to have a favorable water table, but are thoroughly leached of soluble constituents.

Alluvial soils occur locally over much of the state, but are most important on floodplains of the South Platte and Arkansas rivers. The soils are of Recent origin and have been but little affected by the environment. The local character of alluvial soils is dependent on parent materials, the manner of sorting, and the mode of deposition; they are typically pale in color and poor in organic matter.

CLIMATE

The climate of Colorado is sufficiently varied to preclude meaningful generalization. The linear distance between the summit of Pikes Peak (14,110 feet) and Lamar (3622 feet) is only 145 miles, but the difference in mean annual temperature at the two stations is 35°F. Average total annual snowfall at Manassa is 18 inches; at Cumbres, about 30 miles to the southwest, it is 264 inches (Gittings, 1941). Mean annual precipitation is less than 6½ inches at Alamosa in the central San Luis Valley; in the San Miguel Mountains it is more than 50 inches. The mean length of the frost-free season at Grand Junction is 189 days, but at Silverton it is only 14 days (Waters, 1958).

The climate of the eastern plains is distinctly continental. Distance from the sea precludes the ameliorating effects of moist maritime wind systems. Annual and daily ranges of temperatures are broad. This tendency is accentuated by elevation and a consequent rarefaction of the atmosphere. Heating is rapid with the intense radiation, but heat loss at night also is rapid. Air movement is moderately high to quite high, the prevailing winds being from the north or northwest in winter and from the south or southeast in summer. Precipitation and humidity generally decrease from east to west on the plains, with lowest average values recorded in southern Weld County and the Arkansas Valley between Pueblo and Las Animas. A high percentage of the precipitation occurs as rain during the growing reason. For a review of the climate of the Great Plains, see Borchert (1950).

Annual variation in the amount and distribution of precipitation may be marked and a succession of dry years may lead to serious drought, with subsequent deterioration of the range for populations of both domestic and native animals. Weaver and Albertson (1940) and Albertson *et al.* (1957) studied these effects in detail.

The climate of the eastern foothills and immediately adjacent plains generally is less severe than that of the open plains farther to the east. Wind movement in summer is less and daily and annual ranges of temperatures are narrower. In winter, dry, downslope ("chinook") winds are not infrequent; the characteristics of these winds were reviewed by Ives (1950). In general, the mildest winters are experienced at localities near the mouths of larger canyons, such as in the vicinity of Cañon City.

Extreme local variation is typical of mountain climates. To the factors of latitude, prevailing winds, and continentality must be added the effects of altitude and exposure. Elevation modifies air pressure and atmospheric composition, amount and quality of insolation, temperatures of the air and soil and their ranges, direction and velocity of winds, rate of evaporation, humidity, cloud cover, and amount and mode of precipitation. The exposure of a given slope exaggerates these effects, and great local differences may occur between sunny and shaded slopes, wet and dry slopes, and windward and protected slopes (Peattie, 1936).

Temperature decreases with elevation at a rate of approximately 3°F per 1000 feet, with local variation dependent upon slope and exposure. At about 8000 feet, one stands above approximately half of the atmospheric moisture and half of the suspended dust (*op. cit.*). Carbon dioxide is correspondingly reduced. Carbon dioxide and water are the principal heat-absorbing gases of the atmosphere. Thus at higher altitudes there is increasingly less matter to retain heat and, although insolation may be intense, radiative cooling is rapid. Above 9000 feet, frost is possible any night during the year.

Precipitation also varies with elevation, because winds are forced up by a mountain mass and cooled. On higher ranges this increase of precipitation with altitude reaches a maximum at intermediate elevations, above which there is a gradual decline (Daubenmire, 1943). The highest summits are drier than intermediate elevations because moisture-laden winds lose most of their load before topping a summit, and because storms tend to move through passes rather than over crests of mountains. In general, the Eastern Slope lies in a rain shadow and precipitation at a given elevation is less than on the Western Slope. Winter precipitation predominates in the western mountains, whereas summer and winter precipitation are approximately equal on the Eastern Slope, although the effective moisture of snowfall is reduced by the prevalence of chinook winds.

The climate of mountain parks and valleys represents a case of particular interest. North Park and the Upper Arkansas Valley are dry, and the driest part of Colorado is the interior of the San Luis Valley. In each case, these areas lie in rain shadows. Parks and valleys are subject to extreme cold, as alpine air moves downslope and stagnates. Fraser, in Middle Park, records a mean January temperature of about 11°F (minimum, −50°F); Gunnison, in the upper Gunnison River Valley, has a mean January temperature of 7.6°F, with extreme annual temperatures of −47° to 105°F (Gittings, 1941).

The most complex factor in mountain climatology is topography. All other things being equal, western slopes are warmer than eastern slopes and southern slopes are warmer than northern slopes. The degree of relief influences the distribution of precipitation and the velocity of winds. In general, considering features of similar elevation, plateaus are warmer than hills, which, in turn, are warmer than mountains (Daubenmire, 1943).

For thorough discussions of zonation of climatic factors in the Rocky Mountains, see Daubenmire (*op. cit.*) and Baker (1944). Peattie (1936) treated mountain climates in general as an aspect of mountain geography. Geiger (1965) analyzed detailed aspects of mountain microclimates. Climatological data taken along a transect through the Front Range west of Boulder were presented by Marr (1961).

In western Colorado, as in the central mountains of the state, climate is markedly influenced by local topography. High plateaus share many characteristics of mountain climates, whereas low-lying areas, such as the lower valleys of the Colorado and Gunnison rivers and the Four Corners area, are quite dry with generally mild winters. There is a tendency for stationary high-pressure systems to form over western Colorado in winter, causing extended periods of clear weather with warm days and cold nights. Winds in the western part of the state are primarily of the mountain and valley type, and are generally lighter than those of the eastern plains. Erdman *et al.* (1969) discussed in detail the climate of Mesa Verde National Park; this study might be consulted as indicative of climatic conditions over much of the southern part of the Colorado Plateau.

VEGETATION

Previous discussion of the physical setting in Colorado has emphasized the fact that the environment is holocenotic in that each factor is interrelated with each other factor. These in turn affect, and are affected by, the vegetation. The distribution of species of plants is determined over time by the interaction of the environment and the genetically determined tolerances of plants to various environmental parameters. The complexity of the distribution of vegetation is a reflection of environmental complexity. Environmental factors to which plants respond change at various rates and distributions of species change accordingly. Changes in the distribution of constituent species mean changes in the composition of phytocenoses, or plant communities, systems of co-evolving, sometimes competing species with similar or complementary ecological requirements.

Although the vegetation of Colorado is complex and dynamic, limited generalization is possible in describing the broad mosaic of plant communities. Following Costello (1944a, 1954) and Knapp (1965), the treatment will be subdivided into separate discussions of the vegetation of semidesert areas, vegetation of the plains, and vegetation of mountains and plateaus. The subdivisions are generally distinct both floristically and physiognomically, and both of these important aspects of the vegetation will be considered. Summaries of the vegetation of Colorado may be found in Costello (1954) and also in Gregg (1963), and the early survey by Cary (1911) remains a basic reference. In addition to these sources, several vegetation maps are available, which are summaries of knowledge of the distribution of plant communities. In each case, they represent a generalization of the natural situation and must obscure the inherent dynamism of the vegetation. Küchler (1967) detailed the problems of mapping vegetation. Probably the earliest map of vegetation in Colorado was the "Economic map of Colorado," appended to the report of Hayden (1878). A succession of maps by state and federal agencies has followed. A recent example is "Major land resource and generalized land use map, Colorado" (Soil Conservation Service, U. S. Dept. of Agriculture, 1965). Figure 7 is an adaptation of that map. The relationship of the potential natural vegetation of Colorado to that of neighboring states is shown by Küchler (1964). Typical habitats of Coloradan mammals are illustrated in plates 1-8.

Vegetation of the Plains

The greater part of eastern Colorado, the Colorado Piedmont and the High Plains, supports grassland vegetation of various sorts. The grasslands of North America have been the subject of a vast literature, but the complexity of the formation is only beginning to be understood. Some aspects of the grassland have been the subject of considerable controversy. In particular, the influence of fire and of grazing in the maintenance of the climax have been debated.

Large areas of eastern Colorado presently are dominated by short-grasses, in particular *Bouteloua gracilis* and *Buchloe dactyloides.* Costello (1954) and Weaver and Albertson (1956) referred to this short-grass prairie as a disclimax brought about by overgrazing and insisted that the climatic climax of the region is a mixed prairie of short- and mid-grasses. This contention is supported by the fact that mid-grasses persist in protected areas and appear during favorable seasons. Exclosure experiments indicate the ability of mid-grasses to recover when artificially protected. In addition, photographs made by the Hayden Survey in 1870 showed a landscape dominated by mid-grasses.

On the other hand, Larson (1940) emphasized the importance of members of the native fauna such as bison and pronghorn as environmental agents in the maintenance of a short-grass climax. The remarkable ability of blue grama and buffalo grass to withstand overgrazing by domestic livestock was cited as

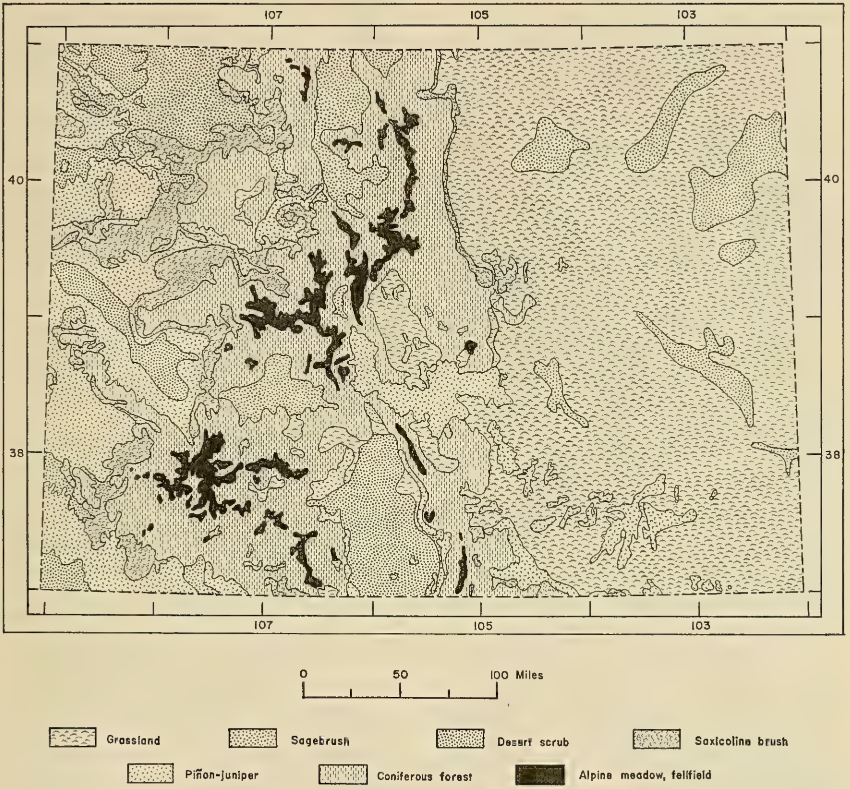


FIG. 7. Vegetation map of Colorado (modified from map, "Major land resource area and generalized land use map—Colorado," U.S. Department of Agriculture, Soil Conservation Service, Portland, 1969).

evidence that heavy grazing pressure has been part of the set of selective forces molding the adapted constitutions of these species.

Similar disagreements might be cited with regard to the importance of fire in the maintenance of the climax. Such arguments frequently tend to over-emphasize parts of the holocenotic environment, to neglect the dynamism of grassland communities, and to underestimate the role of natural disturbance. According to Weaver and Albertson (1956: 25): "When the pioneers came from the East to make their homes in the Great Plains region, they found a dense cover of native vegetation. It was disturbed *only* by buffaloes, prairie dogs, other plains animals, Indians, and prairie fires" (italics mine).

The dynamism of vegetation has its source in the differences in the tolerances of various species, and the consequent semi-independent responses of various species to fluctuations in the plains environment. The point was made explicit by Küchler (1968) in a discussion of problems inherent in mapping dynamic vegetation within static boundaries, stressing the ecological bases of the observed dynamism.

In "normal" years the western border of more typical mixed prairie is related to topography. *Buchloe dactyloides* and *Bouteloua gracilis* are dominant on drier uplands and *Bouteloua hirsuta* is co-dominant on rocky sites. Grasslands of slopes are enriched with mid-grasses, including *Andropogon scoparius.* In swales and along streams, taller grasses such as *Andropogon gerardi* may occur.

In particularly favorable seasons, mid-grasses may "invade" the uplands and tall-grasses may move onto the slopes. In years of drought, on the other hand, mid-grasses move downslope and short-grasses move onto the slopes. Tall-grass may survive only as seeds or be altogether eliminated for a time. On uplands, xeric grasslands may be degraded by the expansion of drought-resistant plants, such as *Opuntia polyacantha* (see Turner and Costello, 1942).

Shantz (1923) mapped six major plant associations in two "communities" in eastern Colorado. His "tall grass community" included a single unit in the state, the "sand grass-sand sage association." This association occurs on sandy soils and dune sand and is the equivalent of the "*Artemisia-Andropogon* prairie" of Küchler (1964). The comprehensive "*Bouteloua-Buchloe* grassland" of Küchler (*op. cit.*) corresponds to the "short grass community" of Shantz (1923), which included five associations: 1) grama grass association; 2) grama grass-buffalo grass association; 3) wire-grass association; 4) grama grass-mountain sage association; 5) grama grass-*Muhlenbergia* association.

The grama grass association, dominated by *Bouteloua gracilis,* forms a narrow band along the western edge of the Colorado Piedmont. The formation occurs on shallow soils; moisture stress precludes the co-dominance of buffalo grass.

The grama grass-buffalo grass association is the most widespread cover of the Colorado Piedmont and the High Plains. Growth often is matlike. Forbs are prominent in wet years. Although moisture is slightly less limiting than immediately along the mountain front, drought may limit the growing season to 30 to 60 days.

Where precipitation is supplemented by seepage, *Aristida longiseta* comes into co-dominance with blue grama and buffalo grass, and the wire-grass association develops. In addition to requiring more moisture than short-grasses alone, the association develops best on deeper soils.

The transition from typical plains grassland to foothills communities was described by Shantz (1923) as the grama grass-mountain sage association. Here *Bouteloua gracilis* occurs with species of *Artemisia* and forbs typical of mountain grasslands—species of *Achillea, Eriogonum, Penstemon,* and *Lupinus,* among others. Soils beneath this association generally are poorly developed, over loose, granitic gravels.

In southeastern Colorado, drought may be severe near the mountains. In such situations a further variant of the short-grass prairie occurs as buffalo grass cedes dominance to *Muhlenbergia gracillima.*

Three important vegetation types were mapped by Küchler (1964) that were not included in the system of Shantz (1923) outlined above. In the extreme east-central part of the state, a fluctuating area of "classic" mixed prairie is to be found. The community is limited to the upper reaches of the Smoky Hill River and is dominated by *Andropogon scoparius, Bouteloua gracilis,* and *Bouteloua curtipendula.* In the valley of the Republican River in eastern Yuma and Kit Carson counties, a grassland dominated by *Andropogon gerardi, Agropyron smithii,* and *Stipa spartea* barely enters the state from the east.

Along the South Platte and Arkansas rivers and their major tributaries, a "northern floodplain forest" of cottonwoods, willows, and other broadleafed deciduous trees and shrubs is developed. The continuity of this formation sometimes is disturbed by fire or by changes in the courses of streams. Prior to control of prairie fires and the impoundment of run-off, such disturbance probably was more widespread and more important.

Detailed local studies of the grasslands of the plains have further elucidated the nature of the vegetation. Ramaley (1939) studied the composition and succession of the vegetation of dune sand and sandy soils near Roggen in Weld County. Sand hills vegetation develops on deep, sandy soils, which retain moisture and have little run-off.

Studies of secondary succession on abandoned plowed land near Nunn, Weld County, were reported by Costello (1944b). The effects of grazing by domestic and native mammals and insects were noted. Shantz (1917) described succession on abandoned prairie roads east of Akron, Washington County.

Vegetation of Semideserts

The vegetation of semidesert areas was divided by Costello (1954) into three kinds of communities based on the dominant shrub species: greasewood, saltbush, and sagebrush. Greasewood communities, dominated by *Sarcobatus vermiculatus,* occur on heavy alkaline soils. On the most alkaline soils, greasewood may form almost pure stands, but in less extreme situations it occurs with saltbush or sagebrush. Development of herb synusiae is minimal. Well-developed greasewood stands occupy large tracts in the San Luis Valley and on broad valley floors in western Colorado. For details of the vegetation of the San Luis Valley, see Ramaley (1942).

Saltbush (*Atriplex*) is widespread in the lower valleys of western Colorado. In general stands develop on soils that are better drained and slightly less alkaline than those occupied by greasewood. Herb synusiae may be moderately well developed under an open stand of saltbush. Saltbush and greasewood communities are combined as "desert scrub" in figure 7.

On its upper edge, greasewood communities frequently contact sagebrush stands. Two distinct sorts of sagebrush communities occur in Colorado. The "sagebrush steppe" of Küchler (1964) occurs in North and Middle parks, the Laramie River Valley, and over much of Moffat County. This community generally has a well-developed understory of herbs. The "Great Basin sagebrush" association occurs in river valleys of the western part of the state and reaches its greatest development in the vicinity of Gunnison. In general, lower synusiae are not so well-developed as in more northern sagebrush communities. For the sake of simplicity, these two sorts of sagebrush associations, and the sand sage communities of the eastern plains, are combined in figure 7.

Vegetation of Mountains and High Plateaus

The vegetation of higher parts of the state is readily divisable into several communities, generally based on the dominance of one or two woody species in that area or zone in which those species are at their competitive optima. On the Eastern Slope, where the mountains rise rather abruptly from the plains, a well-marked series of vegetational zones is apparent; this zonation is complicated by the varied topography of the Western Slope, but the main features are to be seen there also. A well-reasoned and thorough review of vegetational zonation in the Rocky Mountains was presented by Daubenmire (1943). Six major zones were recognized: 1) oak-mountain mahogany; 2) piñon-juniper; 3) ponderosa pine; 4) Douglas-fir; 5) Engelmann spruce-subalpine fir; and 6) alpine. A useful tabular comparison of the zones recognized by Daubenmire with those of several other authors was presented by Gregg (1963). Marr (1961) reported a thorough climatic and ecological survey along a transect west of Boulder between North Boulder and Lefthand creeks over an altitudinal range of 5600 to 12,300 feet. The reader is referred to that paper as an important recent contribution concerning altitudinal zonation of plant communities.

In a sense, the oak-mountain mahogany community represents a transition between the grassland or semidesert and the coniferous woodland. On the Eastern Slope the community forms a narrow band, but scrub oaks cover wide areas in western Colorado, such as the Roan Plateau in Garfield County. Along the eastern flank of the mountains, *Quercus gambelii* occurs commonly northward to Jefferson County, to disappear abruptly in the vicinity of Rocky Flats. *Cercocarpus montanus* occupies a comparable position farther north.

The piñon-juniper community is widespread in southern Colorado, occurring east in the Raton Section to Bent and Baca counties, and in the Upper Arkansas Valley. It is also well represented in western Colorado. The community varies from open and savanna-like to rather dense stands of trees. Herbs are not abundant, but grasses are generally more prominent than are forbs. Dominant trees are *Pinus edulis* and several species of *Juniperus.*

Woodin and Lindsey (1954) made a comprehensive study of piñon-juniper woodlands along the mountain front from the Davis Mountains, Texas, to southern Wyoming. Seven localities in Colorado were surveyed. The communities were dominated by *Pinus edulis* and *Juniperus scopulorum* or *Juniperus monosperma;* piñons had a greater total basal area and a greater frequency at six of the seven sites. A shrub synusia was common. Emerson (1932) studied the relationship of piñon-juniper woodlands to grasslands near Las Vegas, New Mexico. Tree seedlings were found to be unable to compete with established grasses for moisture. The broken topography and coarse soils of the Raton Section and the foothills region were seen as important to the development of the woodland because of their inhibition of grass cover. Rogers (1953) described the vegetation of the Mesa de Maya in southern Las Animas County, emphasizing the importance of topography to the distribution of communities. Erdman *et al.* (1969) considered the ecology of the piñon-juniper community of Mesa Verde National Park. An isolated northern outlier of typical piñon-juniper woodland occurs on limestone escarpments near Owl Canyon, in Larimer County. This particular stand is of considerable ecological interest; it was discussed in semi-technical fashion by Beidleman (1953).

Ponderosa pine and Douglas-fir communities interdigitate in a complicated manner on the Eastern Slope, but they remain generally distinct and occur in response to different site qualities—*Pseudotsuga menziesii* demands more mesic conditions than does *Pinus ponderosa.* Ponderosa pine occurs south on the Eastern Slope to Trinidad and the higher elevations of the Raton Section, and on the Western Slope is abundant between Mesa Verde and the Uncompahgre Plateau. In the northern and western mountains, Douglas-fir is the more characteristic tree. Succession on abandoned cleared land in the ponderosa pine zone near Woodland Park, Teller County, was described by W. M. Johnson (1945).

Pine forests tend to be rather open, allowing the development of herb and shrub synusiae and providing excellent grazing lands. Both pine and Douglas-fir communities may be interspersed with groves of quaking aspen (*Populus tremuloides*). These groves typically have a richly developed understory, particularly on the most mesic sites or following fires. Morgan (1969) reported a study of the ecology of aspen in northern Gunnison County.

At the western end of the divide between the Platte and Arkansas rivers, an open stand of woodland dominated by *Pinus ponderosa* extends this characteristically montane vegetation well out into the plains. The main stand of the community is the so-called "Black Forest" of El Paso and Douglas counties, but the woodland occurs on scarps well into Elbert County. The Black Forest was studied in detail by Williams and Holch (1946) and by Livingston (1949). This woodland seems to be a topo-edaphic climax, traceable to the water-holding capacity of the underlying Castle Rock conglomerate. It is a rather open stand, and adjacent to it are grasslands characterized by several species usually associated with true prairie. Livingston (1952) suggested that the prairie stands are relicts of a formerly more widespread community. Genetic peculiarities of the constituent grass species were described by McMillan (1959).

The so-called "spruce-fir zone" forms a wide belt generally dominated by *Picea engelmannii* and *Abies lasiocarpa.* The trees have a slender habit and may form dense stands precluding the development of an understory. Fire is not infrequent and burned areas are invaded by *Populus tremuloides* when moist; *Pinus contorta* (lodgepole pine) enters openings with good drainage. In northern Colorado dense and extensive stands of lodgepole pine occur, which Moir (1969) recognized as a distinct "zone." Near timberline spruce and fir reinvade burned areas directly, but the process of reforestation is extremely slow.

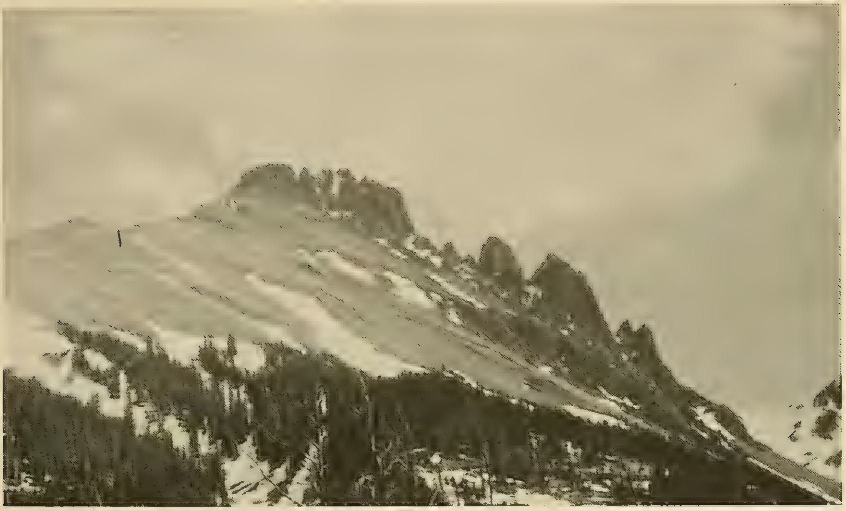
The alpine tundra comprises several plant associations in the area above the limit of tree growth. It is separated from the spruce-fir forest by a band of progressively more prostrate and stunted trees, the "Krummholz" (see Wardle, 1968). For discussion of alpine timberlines, see Daubenmire (1954). The alpine tundra is particularly interesting because of

PLATE 1

1. Shortgrass prairie with isolated groves of cottonwoods, Colorado Piedmont (SE of Agate, about 5400 ft., Elbert County, July 1970). 2. Shortgrass prairie on High Plains (view NE from Two Buttes Peak, Prowers County, elevation of plains about 4400 ft., April 1968).

PLATE 2

1. Disturbed shortgrass prairie (foreground), saxicoline brush and pygmy conifer woodland (background), Raton Section (Purgatoire River Valley, view S from Higbee, about 4100 ft., Otero County, April 1968). 2. Mountain meadow and montane forest, North Park (view E toward Medicine Bow Range from NW of Lindland, about 8000 ft., Jackson County, June 1968).



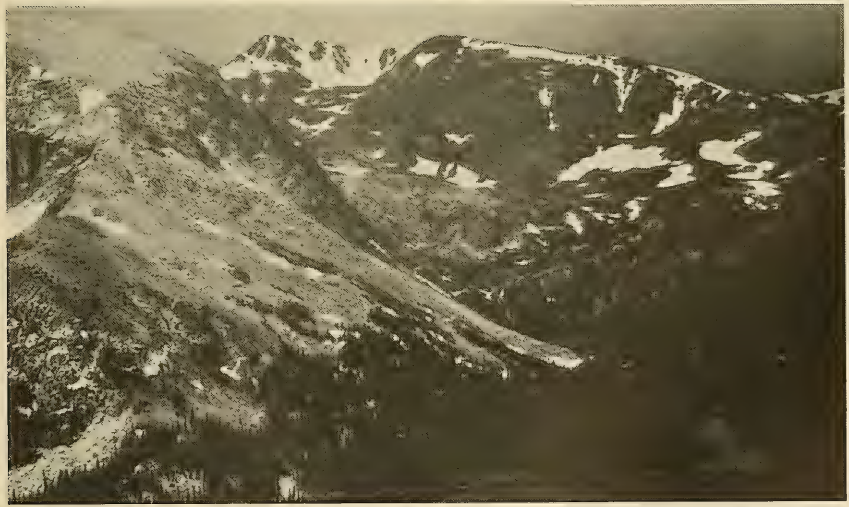
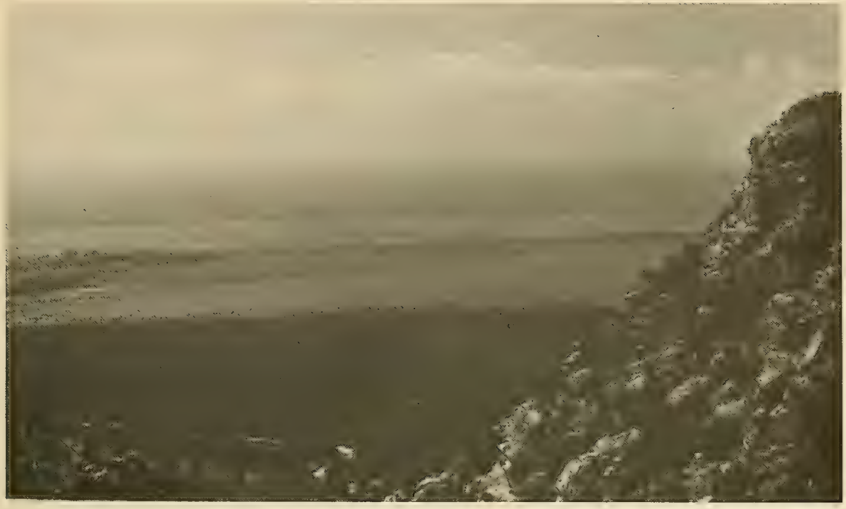


PLATE 3

1. Subalpine forest, krummholz, snowfields (Nokhu Crags, Never Summer Range, 11,000 ft., Jackson County, June 1968). 2. Subalpine forest, fellfield, snowfields—note U-shaped glacial valley and prominent cirque at left (Front Range across Upper Big Thompson River, view SW from Forest Canyon Overlook, Trail Ridge Road, 11,600 ft., Rocky Mountain National Park, July 1970).

PLATE 4

1. Beaver pond in montane forest (Elkhorn Creek, 8000 ft., Larimer County, June 1968). 2. Mountain grassland, South Park (view SW from Kenosha Pass toward Sawatch Range, 10,000 ft., Park County, August 1970).



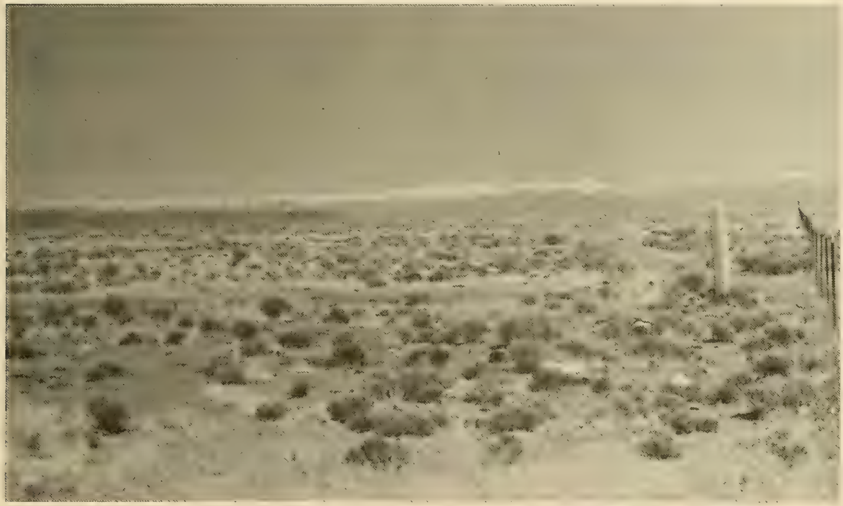
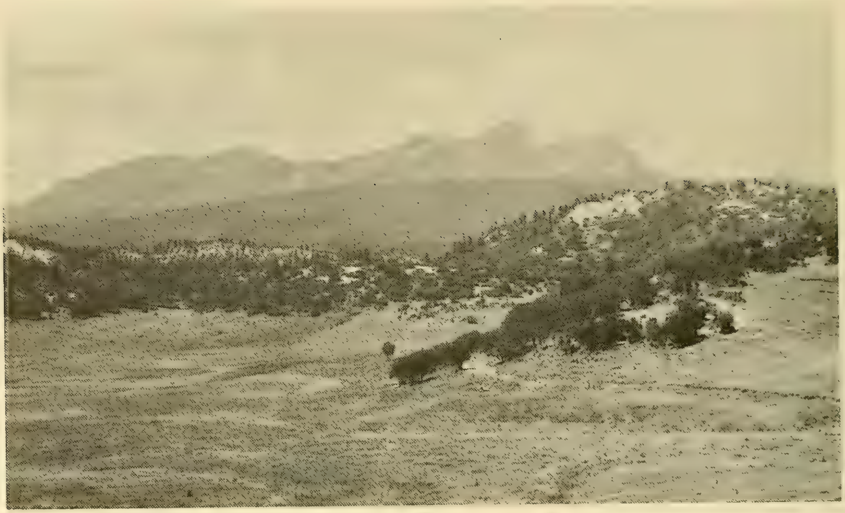


PLATE 5

1. Semidesert grassland, pygmy conifer woodland, San Luis Valley (view WSW from near mouth of North Crestone Canyon, 7500 ft., Saguache County, July 1969). 2. Semidesert scrub, San Luis Valley (view E toward Culebra Range along Colorado-New Mexico boundary, near Garcia, 7700 ft., Costilla County, April 1969).



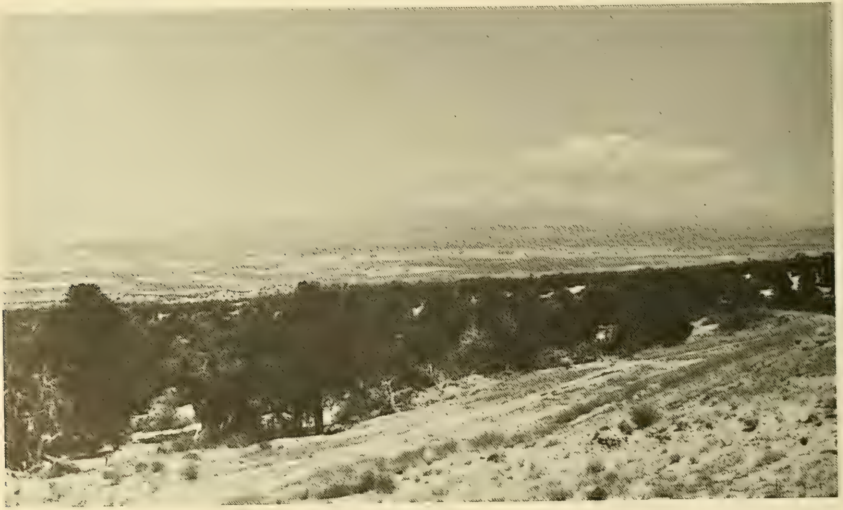


PLATE 6

1. Mountain grassland and ponderosa pine woodland, Navajo River drainage (view N from New Mexico boundary, SE of Chromo, toward Navajo Peaks, 7200 ft., Archuleta County, August 1969). 2. Semidesert scrub, pygmy conifer woodland, Navajo Section (view N toward San Juan Mountains, La Plata Co., Colorado, from San Juan Valley, about 6000 ft., San Juan Co., New Mexico—photo by R. R. Patterson, August 1969).

PLATE 7

1. Oakbrush with scattered conifers, San Miguel Valley (view S from Uncompahgre Plateau above Redvale, toward Lone Cone and San Miguel Mountains, Montrose and San Miguel counties, about 8000 ft., August 1969). 2. Semidesert scrub, Grand Valley, view N from Red Canyon Overlook, Colorado National Monument, toward Grand Mesa, right, and Book Cliffs, left, about 5500 ft., Mesa County, August 1969).

PLATE 8

1. Oakbrush, Roan Plateau (near Douglas Pass, about 8000 ft., Garfield County—photo by C. Edmondson). 2. Brush and woodland mosaic, Wyoming Basin—note prominence of spruce in protected pockets of cliff-face (near junction Yampa and Green rivers, Dinosaur National Monument, about 5600 ft., Moffat County, September 1968).

the Holarctic relationships of the flora. Daubenmire (1943) estimated that 37 per cent of the species occurring in the Coloradan alpine tundra are also found in the Arctic. The flora is almost entirely perennial and shoots are generally dwarfed. Fire is essentially unknown in the alpine zone.

Identification of communities in the alpine zone has proved challenging to phytocenologists. Knapp (1965) disinguished six community-types: fellfields, dry meadows, wet herb-meadows, snowfield vegetation, dwarf willow communities, and sedge marshes. Marr (1961) recognized 10 major stand-types in the "alpine tundra climax region" on Niwot Ridge, west of Boulder.

The frequent use in the literature of the term "arctic-alpine" zone suggests a lack of appreciation for the differences between arctic and alpine tundra environments. Vegetation is similar in arctic and alpine tundras, both physiognomically and floristically, but physical factors differ markedly. In addition, vertebrate faunas differ widely and have distinctive histories (see Hoffmann and Taber, 1967). Bliss (1956) compared micro-environments at Umiat, Alaska, and in the Snowy Range of southern Wyoming.

Absolute elevation and vertical extent of the various vegetational zones in the mountains of Colorado is a result of a complex of local factors. In general, however, the alpine zone is limited to the highest mountain ranges and begins at elevations of from 11,500 to 12,000 feet, with local variation depending on latitude and topography. The spruce-fir zone begins at 8500 to 9000 feet, except on the borders of the San Luis Valley, where ponderosa pine-Douglas-fir forests extend on slopes to 9500 feet. The spruce-fir forest generally occupies the mountain ranges, but extensions occur from the western ranges onto the Uncompahgre and White River plateaus and Grand Mesa. The contact between ponderosa pine woodlands and mountain shrub or piñon-juniper formations occurs at 6000 to 7000 feet (Costello, 1954).

PLEISTOCENE ENVIRONMENTS

Modern patterns of mammalian distribution in Colorado have evolved against the background of the Pleistocene environment. Unfortunately, as Deevey (1965:643) has observed, ". . . extremely little is reliably known about Pleistocene habitats, especially at times and in places where there were no glaciers." This observation is particularly well justified insofar as Colorado is concerned, for data on Pleistocene events other than alpine glaciation are few indeed. As a result of the paucity of information, discussion of the Pleistocene environment must be incomplete, and data presented cannot be generalized readily over broad areas of the state.

As in geomorphic history, so in the record of the Pleistocene Epoch did the mountains of Colorado play a dominant role. Although continental glaciers did not reach the state, periodically in the Quaternary Period glaciers occupied numerous valleys in all major ranges through the Rocky Mountains southward to central New Mexico, and ice caps formed on the White River Plateau, the White River Flat-tops, Grand Mesa, and in the San Juan region. For an indication of the spatial relationship between alpine and continental glaciers, see Fenneman (1931:72) or Dorf (1960: 353).

Richmond (1965) reviewed the history of investigations of alpine glaciation in the Southern Rocky Mountains, citing much of the pertinent literature. Additional literature, much of it local in scope, is cited in the bibliography entitled "Geologic and water supply reports and maps, Colorado, August, 1969," available from the U. S. Geological Survey, Denver Federal Center.

Richmond (1965) outlined a sequence of five episodes of glaciation during the Pleistocene. This sequence was followed by a warm, dry stage, the Altithermal Interval, which was succeeded by another glacial stage, the Neoglaciation. The latter period, frequently called the "Little Ice Age," consisted of two episodes of cirque glaciation. Deevey and Flint (1957) suggested the use of the term Hypsithermal rather than Altithermal. The Hypsithermal Interval includes the widely-known Boreal, Atlantic, and Sub-boreal zones of the North German pollen sequence. The etymological hybrid "Altithermal" is generally retained here, however, following the usage of Richmond (*op. cit.*).

<table>
<tr><th>Years B.P.</th><th colspan="3">ROCKY MOUNTAINS</th><th colspan="2">MID-CONTINENT</th></tr>
<tr><td>800</td><td rowspan="3">Neoglaciation</td><td colspan="2">Gannett Peak Stade</td><td rowspan="4" colspan="2">Recent</td></tr>
<tr><td>900</td><td colspan="2">Interstade</td></tr>
<tr><td>4000</td><td colspan="2">Temple Lake Stade</td></tr>
<tr><td>6500</td><td colspan="3">Altithermal Interval</td></tr>
<tr><td>10,000</td><td rowspan="5">Pinedale Glaciation</td><td colspan="2">Late Stade</td><td rowspan="9">Wisconsin Stage</td><td>Valderan Substage</td></tr>
<tr><td>12,000</td><td colspan="2">Interstade</td><td>Twocreekan Substage</td></tr>
<tr><td></td><td colspan="2">Middle Stade</td><td rowspan="2">Woodfordian Substage</td></tr>
<tr><td></td><td colspan="2">Interstade</td></tr>
<tr><td>24,000</td><td colspan="2">Early Stade</td><td>Farmdalian Substage</td></tr>
<tr><td>32,000</td><td colspan="3">Interglaciation</td><td rowspan="4">Altonian Substage</td></tr>
<tr><td>45,000</td><td rowspan="5">Bull Lake Glaciation</td><td rowspan="3">Late Stade</td><td>2nd Episode</td></tr>
<tr><td></td><td>Non-glacial Interval</td></tr>
<tr><td></td><td>Ist Episode</td></tr>
<tr><td></td><td colspan="2">Non-glacial Interval</td><td rowspan="3" colspan="2">Sangamonian Stage</td></tr>
<tr><td></td><td colspan="2">Early Stade</td></tr>
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<tr><td></td><td colspan="3">Sacagawea Ridge Glaciation</td><td colspan="2">Illinoian Stage</td></tr>
<tr><td></td><td colspan="3">Interglaciation</td><td colspan="2">Yarmouthian Stage</td></tr>
<tr><td></td><td colspan="3">Cedar Ridge Glaciation</td><td colspan="2">Kansan Stage</td></tr>
<tr><td></td><td colspan="3">Interglaciation</td><td colspan="2">Aftonian Stage</td></tr>
<tr><td></td><td colspan="3">Washakie Point Glaciation</td><td colspan="2">Nebraskan Stage</td></tr>
</table>

FIG. 8. Correlation of glacial sequence of Rocky Mountains with North American mid-continental sequence (after Richmond, 1965).

The sequence of glacial advances and its tentative correlation with the Quaternary glacial sequence of mid-continental North America is shown in figure 8 (after Richmond, 1965). The succession of deposits described and named from the Wind River Mountains of Wyoming by Blackwelder (1915) is used as a standard for regional correlation. The following discussion of glaciation follows Richmond (1965).

The earliest advance of Pleistocene ice is termed the Washakie Point Glaciation, in which the maximum extent of valley glaciers was less than in succeeding stages. In the Northern Rocky Mountains, ice flowed down valleys to create coalescent lobes at the mountain front, but to the south, glaciers terminated well up in the canyons. True piedmont glaciers are not known from the Pleistocene of Colorado.

The Cedar Ridge Glaciation was similar in general distribution to the earlier Washakie Point stage, but was somewhat more extensive in that ice moved lower in valleys. The Sakagawea Ridge Glaciation succeeded the Cedar Ridge stage. Glaciers were generally thick and confined to valleys cut by the erosion cycle of the preceding interglacial period. The glaciers commonly extended farther downstream than those of the ensuing Bull Lake Glaciation. The average lower limit of ice has been estimated at 8000 feet in southern Colorado and at 6000 feet in central Wyoming.

Intervening between successive glacial advances were periods of weathering and extensive pedogenesis. The soils produced are thick, and their character and extent suggest that interglacial intervals were warmer than the present. That precipitation was variable was suggested by the complex pattern of pedocals and pedalfers, developed under a dynamic vegetational cover.

Bull Lake glaciers in Colorado were 10 to 15 miles long, although local conjunction of valley glaciers with cap ice, such as on the White River Plateau and in the San Juan Mountains, formed much more extensive deposits. Commonly two, sometimes three, terminal moraines mark the extent of stades of this glacial interval. The stades were separated by non-glacial periods during which deglaciation was complete.

The Pinedale Glaciation is the most recent Pleistocene glacial interval, hence the best known. It is represented by three terminal moraines, commonly smaller than, and lying directly above, those of Bull Lake age. Ice caps were of lesser extent. The three stades of the Pinedale Glaciation were separated by interstades during which weathering produced thin soils. Pedogenesis continued during the Altithermal Interval, following the close of Pinedale Glaciation. Both Bull Lake and Pinedale times saw the development of altitudinal zonation of soils during non-glacial intervals. During Bull Lake time, pedalfers developed above 7500 feet in central Colorado; the boundary of forest soils was some 200 feet lower in Pinedale time.

Since the end of the Altithermal Interval, two minor advances of cirque glaciation have occurred. These advances constitute the Neoglaciation (see Outcalt and MacPhail, 1965). The earlier Temple Lake Stade was more extensive than the Gannett Peak Stade. Glaciers of the latter period have been in contact with their terminal moraines within historic times. Small glaciers remain in sheltered parts of the Colorado mountains, and perennial snowfields occur widely. The greatest extent of glacial remnants is in the Front Range, near the Continental Divide west of Boulder.

Ecological conditions throughout Colorado during the Quaternary Period have been influenced by the same perturbations of climate that prompted the development of valley glaciers and cap ice. In addition, conditions have been affected by the presence of glaciers themselves. With the record of alpine glaciation in mind, an attempt will be made to establish certain characteristics of non-glacial environments in Colorado. Of particular interest are events of Pinedale and post-Pinedale age. Data bearing on the problem are both actual and theoretical.

The glacial sequence in the mountains was paralleled by fluctuating conditions on the western plateaus and on the plains to the east. Scott (1960) identified the recurrence of a geomorphic cycle five times during the Pleistocene based on study of the alluvial sequence on the Colorado Piedmont near Denver. Each cycle was contingent upon climatic fluctuation. The coldest, wettest phase of the cycle was marked by downward cutting by streams heading in the mountains. With warming and drying, sideward cutting ensued, and continuation of that climatic trend led to increasing alluviation. Eolian erosion and deposition marked the driest phase of the cycle. Such periods were followed by a pedogenic phase influenced by a moister but only slightly cooler climate. Further decrease in temperature and increase in moisture marked the beginning of renewed downward cutting and the initiation of a new cycle.

On the Colorado Plateau, the sequence is not known in such detail, but Hunt (1956) distinguished "pre-Wisconsin," "Wisconsin," and Recent features. Pre-Wisconsin deposits include extensive fluvial and eolian deposits at the northwestern base of the San Juan Mountains and pediments and fanglomerate at the foot of the Book Cliffs. Among Wisconsin deposits are glacial and periglacial features of various kinds on and near the mountains, fanglomerate on pediments and in alluvial fans, terrace gravels and alluvium, colluvium and talus on valley walls, and eolian deposits and residual soils on upland areas.

The early Pleistocene of the Colorado Plateaus was marked by erosion; later, periods of erosion and sedimentation alternated and downward cutting of the horizontal beds was not extensive. The Quaternary record of the area indicates alternation of aridity with cool, dry periods. The overall pattern was complicated by volcanic activity and diastrophism (Kottlowski *et al.*, 1965). On the Colorado Plateaus as on the High Plains, late Pleistocene alluvium commonly is homogeneous, whereas Recent alluvium occurs in coalescing fans (Hunt, 1953). These are differences to be expected between deposits of perennial and ephemeral streams (Schumm, 1965).

In the mountain parks, conditions apparently were rigorous during times of glacial advance. Stark *et al.* (1949) believed that a periglacial climate with low temperatures and strong, cold winds must have prevailed in South Park during glacial intervals. In general, North, Middle, and South parks were subject to erosion during the Quaternary, with formation of pediments and terraces by glacier-fed streams (Scott, 1965). As is usual in such situations, direct evidence of environmental conditions is lacking.

The San Luis Valley, on the other hand, has been aggraded throughout later Tertiary and Quaternary times, except locally at the northern end of the valley and in the "Culebra re-entrant" (of Upson, 1939) south of Fort Garland. Eolian sands in the eastern part of the valley are of Pleistocene and Recent age (Scott, 1965). An extensive area of spectacular transverse dunes is preserved in Great Sand Dunes National Monument.

Theoretical approaches to the paleoenvironment in and adjacent to the Southern Rocky Mountains frequently have involved estimates of the depression of altitudinal zones —Life-Zones or orographic snowlines. Orographic snowline commonly is taken as the median elevation between the head of a cirque and its correlated terminal moraine, but other authors define it as the average elevation of cirque-floors. Stearns (1942) estimated a lowering of Life-Zones in northern New Mexico by 4000 to 4500 feet, on the basis of late Pleistocene remains of *Marmota flaviventris* from a deposit southwest of Santa Fe at an elevation of 5900 feet. Although based on a misunderstanding of the "niche breadth" of the marmot, that estimate is not far removed from those based on other kinds of evidence.

Leopold (1951) utilized late Pleistocene snowlines and radiosonde data on free air temperatures along the mountains to estimate Late Pleistocene temperatures for the region. He assumed that the Pleistocene snowline, like that of the present day, was controlled by summer temperatures, and that the modern lapse rate of 6°C per 1000 meters was applicable. In addition, it was postulated that summer temperatures were lowered much more with respect to modern values than were winter temperatures, causing a graduated reduction of temperatures each month with maximal reduction in July and no reduction in January. At its maximum depression, snowline lay at about the elevation of Fraser (8700 feet) at that latitude (about 40° N). At Fraser, mean annual temperature at present is about 32°F. With a depression of snowline by some 1500 meters to the elevation of Fraser, mean annual temperature would have been 24°F and the present mean July temperature would have been reduced by 16.2°F.

Antevs (1954) estimated changes in snowlines to arrive at a maximum depression of 3000 feet on Pikes Peak. Mean reduction of June-September temperature was placed at 10°F. At Santa Fe, New Mexico, snowline depression was calculated to be 4000 feet, similar to the estimate by Stearns (1942) based on the former range of *Marmota.* A table correlating the Life-Zones of present-day New Mexico (based on Bailey, 1932) with those at the glacial maximum was presented by Antevs (1954:185). Alpine conditions were thought to have existed down to about

9000 feet, Hudsonian forest to about 7000 feet, with Canadian forest and Transition woodland occupying the foothills. Upper Sonoran woodland and steppe occupied areas presently covered with desert grassland and creosote bush.

Richmond (1965) estimated the late Pleistocene depression of regional snowline to have been 4000 feet. Mean summer temperatures in the Southern Rocky Mountains were thought to have been 16°F cooler than at present, but winter temperatures were much the same as today.

Dillon (1956) reviewed the literature on Wisconsinan and post-glacial climates of North America in terms of Life-Zones, taking the theoretical system of Merriam (1894) rather literally. He stated (*op. cit.*:175): "Life zones, which ignore historical influences, are particularly unsatisfactory in the western states. . . ." As will be discussed at length beyond, Life-Zones in the descriptive sense have found their greatest use in the West. Dillon (*op. cit.*) presented maps of Quaternary climatic belts that aid in visualization of the magnitude of ecological change from the Wisconsin to the present.

Actual data on Pleistocene and early Recent environments come from a variety of sources, including studies of paleontology, palynology, and archeology. Relevant studies have been few and the best of them provide data appropriate to only narrowly circumscribed areas. Nonetheless, it will be from a synthesis of many such studies that a composite picture of the dynamic Quaternary environment eventually will be drawn.

Direct evidence of the early distribution of mammals in Colorado is meager. No excavation of a Pleistocene mammalian local fauna has been made within the state (see Hibbard, 1958), although limited mammalian remains from terrace deposits have been reported (Hunt, 1954; Scott, 1963; Scott and Lindvall, 1970). Faunas from southwestern Kansas have been studied in detail, however, revealing trends in the environment of the High Plains, and cave faunas recently reported from southeastern Wyoming could yield similar data pertinent to the foothills of the Eastern Slope in Colorado (see beyond).

The most nearly complete sequence of Late Cenozoic faunas in a restricted area anywhere in the world is recorded in deposits in southwestern Kansas and adjacent Oklahoma. The record has been worked out, mostly since 1936, by C. W. Hibbard and co-workers from the universities of Kansas and Michigan. It seems probable that trends seen in the Pleistocene environment of southwestern Kansas may be extrapolated to eastern Colorado—at least to the southeastern part of the state, and with due reservation to parts of the Colorado Piedmont as well.

Southwestern Kansas is well situated to have preserved a record of climatic change during the Pleistocene epoch (Hibbard and Taylor, 1960). The area lies on the modern boundary between dry subhumid and semiarid climatic types. Fossil assemblages of molluscs and vertebrates record wide east-west variation in the position of that boundary. Pleistocene faunas also appear to record appreciable north-south shifts in isotherms. The area studied is located in the central Great Plains, where air masses from the Gulf of Mexico and the Arctic pass unimpeded by mountains. Those same air masses affect life throughout a broad region. Therefore, faunal succession in a local area may indicate climatic change over wide areas of the continental interior.

The stratigraphic sequence in Meade County, Kansas, and surrounding areas was reviewed by Hibbard (1949). Hibbard *et al.* (1965) reviewed the mammalian local faunas of the region. D. W. Taylor (1965) summarized interpretations of Pleistocene climates based on both molluscan and vertebrate faunas. Throughout the Pleistocene prior to the Wisconsin Stage, differences between glacial and interglacial climates were essentially similar, suggesting cyclic climatic change. All pre-Wisconsin climates were markedly less continental than modern climates. None of the known pre-Wisconsin molluscan faunas could live under the present regime of extreme winter cold and summer heat. Cyclic recurrence of similar climates favored the redevelopment of similar molluscan faunas at different times. During the Wisconsin Stage, a cool-steppe fauna predominated, suggesting cooler summers and a lower mean annual temperature than previously during the Pleistocene Epoch.

An intriguing, if stratigraphically equivocal, mammalian local fauna was described recently by E. Anderson (1968) from the foothills of the Laramie Mountains, west of Douglas, Wyoming. The site, known as Little Box Elder Cave, was excavated over a period of 15 years by workers from the University of Colorado Museum. The depositional sequence within the cave has not been determined satisfactorily, nor has the deposit been dated positively, but the cave is interpreted to contain remains of both Wisconsin and Recent ages. Faunal composition and deposition are such as to indicate four sources of mammalian material: 1) remains from owl pellets; 2) accumulations of bones by mammalian predators and bones of the predators themselves; 3) accumulation by rodents, particularly woodrats; 4) accumulation incident to early human occupancy. The latter two sources of material also are potential sources of disturbance to the depositional sequence. Little Box Elder Cave is one of the richest "local faunas" discovered to date; 60 species of 47 genera have been identified with excavation about two-thirds complete. The heterogeneity of the fauna is impressive and in part probably reflects the disturbance of several successive strata. Nevertheless, the presence of the collared lemming, *Dicrostonyx,* and of several highland and boreal mammals (including *Microsorex hoyi, Marmota flaviventris, Clethrionomys gapperi, Phenacomys intermedius, Gulo gulo, Martes americana*) at an elevation of 5500 feet is a matter of great interest.[1]

The fauna of Horned Owl Cave, northeast of Laramie, Wyoming, is less extensive than that of Little Box Elder Cave, but the assemblage indicates a similar diversity of sources of material. Of particular interest in the fauna is the presence of *Ochotona princeps* and *Phenacomys intermedius* at moderate elevations, and the occurrence of *Oreamnos americanus* in the Southern Rocky Mountains (Guilday *et al.,* 1967).

Gebhard (1949) investigated deflation basins in Yuma County, Colorado, where fossil molluscs yielded local detail on the Wisconsin environment. He interpreted the history of the blowouts to have begun with deflation of a sandy plain with thin topsoil. With increased precipitation or decreased evaporation (or both), shallow lakes were formed and marl deposited. With a return to drier conditions, the lakes dried and the basins were covered with soils that followed the shrinking shoreline. More recently, the basins were again deflated, exposing the fossiliferous marl. Sixteen species of freshwater molluscs have been identified from the deposits. Among them is a gastropod, *Lymnaea stagnalis,* that cannot estivate in mud. *Menetus exacuous,* a woodland species that lives near water, also was present in the deposits, suggesting that at the time of deposition of the marl the area must have been forested, at least around the margins of lakes. Hunt (1953) placed the age of the above-mentioned deposits at Late Pleistocene or early Recent, and suggested similar moist conditions in the vicinity of the present-day city of Denver at that time. The depauperate Recent molluscan fauna of the Great Plains stands in marked contrast to both glacial and interglacial Pleistocene faunas, indicating that aridity and extreme continentality are a late or post-Wisconsin development (D. W. Taylor, 1965).

Bryan and Ray (1940) made extensive studies of the Lindenmeier Site, source of a paleo-Indian complex, near the Colorado-Wyoming boundary north of Fort Collins. The authors attempted to reconstruct climatic conditions in the area while Pinedale glaciers occupied nearby mountain valleys. A basic assumption was a cooler, more humid climate than at present and decreased evaporation, but the region adjacent to the mountains would be subject to cold drying winds from the west. Descending as cold winds from the mountains, they would be warmed to become drying winds on the plains. Permeability of surficial deposits coupled with the irregularity of the topography would further limit the amount of effective precipitation. Bryan and Ray concluded that even in late Pleistocene times there were extensive grasslands along the mountain front, interrupted by scattered, park-like coniferous forests.

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[1] After the foregoing paragraph was written, Long (1971) published a discussion of some zoogeographic implications of the fauna of Little Box Elder Cave.

Data bearing directly on the condition of the montane environment during the Pleistocene are few. An important source of data, palynology, remains virtually untapped. Maher (1961) studied pollen sediments from Pinedale and post-glacial bogs in the Animas Valley, between Durango and Silverton, in southwestern Colorado. The data indicated that a tundra vegetation was replaced by subalpine forest some 13,500 years ago. Prior to reforestation, tree-line was at least 1900 feet lower than at present.

Pennak (1963) studied pollen sediments from bogs and lakes in the Front Range west of Boulder. Post-glacial events reflected in the sediments were interpreted as follows. At higher elevations, subsequent to the recession of Pinedale glaciers there was a short period of open forest, the pollen rain consisting chiefly of pine and sagebrush and a small amount of spruce. This was followed by a short, dry Boreal period, characterized by an increased percentage of *Pinus* pollen and reduced amounts of *Artemisia* and *Picea*. The Hypsithermal Interval extended from 6000 to 3000 years BP, and was sharply defined as a warm, dry period with an abundance of grass pollen and reduced amounts of arboreal pollen. During the past 3000 years, terrestrial vegetation appears to have remained remarkably constant. Areas from about 7500 to 11,500 feet have maintained a stable and characteristic climax vegetation.

Evidence offered by Pennak (*op. cit.*) in support of a warm, dry Hypsithermal Interval was qualified by Weber (1965:457), who suggested that the sample might represent local edaphic conditions. However widely applicable the conclusions of Pennak (*op. cit.*) may be, certainly they suggest the great potential of continued palynological study in the reconstruction of past Coloradan environments.

Any widespread concensus on the nature and magnitude of fluctuations in Pleistocene and post-glacial climates in North America probably is impossible. A diversity of interpretations has resulted from attempts to apply to broad areas hypotheses derived locally on the basis of a circumscribed set of data. In the Prairie Peninsula of eastern North America, for example, P. W. Smith (1958) documented four sorts of post-glacial climatic change based on distributional peculiarities of vertebrates. Deevey (1958) noted that pollen stratigraphy in glaciated areas suggested such changes, whereas the record from well south of the glacial border indicated two climatic phases. Martin (1963) summarized the debate over post-pluvial climatic change in the Southwest. Hoffmann and Jones (1970) presented a detailed review of Late Pleistocene and Holocene faunas of the Northern Great Plains, following Bryson *et al.* (1970) in their 12 distinctive climatic episodes.

In Colorado, direct evidence of the glacial and post-glacial climatic changes that affected patterns of mammalian distribution is meager. The assumption must be made that since their uplift the Southern Rocky Mountains have dictated strong climatic differences within Colorado. Climatic generalization over the state must be as nearly impossible for the past as it is at present. Only a synthesis of many future local studies will allow reconstruction of the dynamic environmental mosaic of Pleistocene and Recent times. Patterns of distribution and differentiation of Coloradan mammals may prove to be an important datum in such a synthesis.

EFFECTS OF MAN ON MAMMALIAN ENVIRONMENTS

The effects of aboriginal man on the environment of Colorado are difficult to assess. Over much of the state, the effects probably were minimal, because human populations were low prior to the advent of European settlement. With settlement of the area during the mid-Nineteenth century, the effects of man on the environment were greatly increased (see Quick, 1964). Probably the first effects on mammalian populations were direct. Fur-bearers of economic importance were reduced in numbers (mink, beaver) or extirpated (otter). Big-game populations were reduced dramatically in certain sections and native herds of bison were eliminated altogether, as were elk in some areas. Especially detrimental was the pressure of market-hunting.

As settlement continued, the stringent control of mammalian predators and agricultural pests became common practice. Here also, certain populations were reduced to low levels or completely eliminated. The extirpation of the wolf and perhaps the grizzly bear in Colorado are cases in point. Many methods of control were utilized that were non-selective or had untoward secondary effects. In a number of instances, mammalian species of neutral or positive value to human interests were seriously affected. Among the unintended casualties of control policies were the swift fox, the spotted skunk, and the black-footed ferret.

Commensal Old World rats and mice accompanied man in the colonization of the land, and these rodents undoubtedly have had some effect on the local distribution of native mammals. These relationships have not been studied in detail in Colorado, but such studies would be of interest.

Changes in the environment brought about by man have also had indirect influence on mammalian distribution. The effects have been both positive and negative, but in all cases the "natural" distribution of populations has been obscured. The importance of such influences on mammalian distributions is almost impossible to assess adequately, for one must consider the dynamism inherent in populations and communities, and also the possibility of response to environmental change that is other than anthropogenic. Alteration of the native vegetation has doubtless been the most important of indirect influences. While there may be more individual fires at present than previously, it is certain that fires are far less extensive today than in the past. Fire as a natural ecological agent has been virtually eliminated over wide areas of the plains. On the forested highlands, lumbering has encouraged seral communities and has perhaps assumed a part of the role of fires of the past, although the overall influences of timber-cutting and of fire are in no sense directly comparable.

Agricultural enterprises in the eastern part of the state have progressed by turning under the tough, native short-grass sod, and replacing it with exotic crops. Typically, bringing land under cultivation drastically simplifies the biotic community of a given site. Such conditions favor some kinds of mammals over others. In some instances, the establishment of cultural, replacement communities has meant a greater potential energy source for the remnants of the natural biotic community. In years of drought, however, the removal of native vegetation has led to disasterous consequences.

Intensive agriculture over much of Colorado is impossible without irrigation, and irrigation systems have altered the environment markedly. Not only is the water balance of irrigated lands affected, but also that of adjacent areas. The impoundment of water in large irrigation reservoirs has created many miles of shoreline communities in eastern Colorado, which were practically non-existent previously. There are fewer reservoirs on the Western Slope at this time, but those that do exist (and are proposed) cannot be without serious effect. Fortunately, recent impoundments in the San Juan and Gunnison watersheds have been preceded by ecological surveys of the affected areas (see Harris, 1963; Durrant and Dean, 1959, 1960, 1961; Durrant and Robinson, 1962). With these surveys as a base, studies of the long-term influence of impoundments on biotic communities will be possible. Superficially, it is obvious that irrigation has destroyed or limited the habitat of a number of native species over wide areas, and also has provided, or will provide, wide access for other mammals to areas that previously were unsuitable and beyond the limits of tolerance.

Throughout the state, grazing by domestic livestock has affected the quality of the native range with consequent effects on local wildlife. In particular, over-grazing has had serious consequences, altering the native vegetation, abetting the process of erosion, and distorting the local balance between producers and consumers. Historically, mountain valleys and parks were pre-empted by ranching interests. Native mammals were thereby prevented access to winter range. For a discussion of the importance of this situation in Estes Park, see Wright *et al.* (1933). Presently, some sheep-growers on the Western Slope are calling for widespread alteration of the vegetation by "chaining" native scrub and pygmy conifer stands. This practice must have serious, long-term repercussions for the native fauna, as well as on the quality of the watershed. For a preliminary study of these effects in Arizona, see Turkowski and Brown (1970).

In the mountains, mining operations have altered vegetation, polluted streams, and created habitat for cavernicolous bats in areas where suitable natural habitat for such kinds is limited.

Even so mundane an activity as the construction of a highway or railroad may affect the local mammalian community profoundly. Construction involves the alteration of native substrate, and the vegetation of rights-of-way frequently is quite different from that of adjacent grazing lands or fallow fields. Also, railroads and highways have divided the foraging ranges of some species, as have certain logging and mining practices.

In a very real sense, much of our study of the distribution of mammalian populations today is "salvage zoology," an attempt to understand patterns of distribution and symbiotic relationships before they are destroyed or distorted by human intervention to the point of being ecologically or historically meaningless or even maladaptive. The effects of man are widespread, easily seen, and readily deplored, but mammalian species are influenced in different ways and to different degrees by human disturbance of the habitat. For this reason, where possible, specific cultural effects on mammalian distribution within the state are noted in the accounts of species beyond.

ACCOUNTS OF SPECIES

One hundred twenty-one species of Recent mammals, representing seven orders, are known to occur in Colorado, or to have occurred there within historic times. These species are treated herein as 211 named kinds —subspecies or monotypic species. Of that number, three species are of occasional occurrence only, and native stocks of as many as six species may have been extirpated since permanent European settlement in Colorado. Populations of at least three exotic mammals are established in the state, and local feral populations of other introduced species are known to occur intermittently. Introduced mammals and species of probable occurrence in Colorado are treated briefly following accounts of native species.

KEY TO ORDERS OF COLORADAN MAMMALS

1. Forelimbs modified for flight .... Chiroptera
Forelimbs not modified for flight 2

2. Upper incisors absent .... Artiodactyla
Upper incisors present 3

3. Canines present, no pronounced diastema 4
Canines absent, diastema pronounced 6

4. Incisors 5/4; hallux opposable .... Marsupialia
Incisors 3/3 or fewer; hallux not opposable 5

5. Canine not markedly longer than adjacent teeth; size small, total length less than 200 .... Insectivora
Canine markedly longer than adjacent teeth; size medium to large .... Carnivora

6. Incisors 2/1 .... Lagomorpha
Incisors 1/1 .... Rodentia

Order MARSUPIALIA

A single species of marsupial, *Didelphis marsupialis,* is indigenous to North America north of the Rio Grande, although members of the Neotropical genus *Marmosa* have been carried into Colorado inadvertently by man. The opossum, a medium-sized mammal with a nearly naked, prehensile tail, cannot be confused with any other Coloradan mammal.

FAMILY DIDELPHIDAE—OPOSSUMS

Didelphis marsupialis

OPOSSUM

Didelphis marsupialis appears to have entended its range westward to Colorado within the last century; I have found no reference to it in the historical literature. The first report of the species from the state (Cary, 1911:52) was of an individual observed in the winter of 1903-1904 near the head of Caddoa Creek in southern Bent County. Warren (1942:3) knew of no other reports of *Didelphis* in Colorado.

Gruchy (1950) made a brief survey of the status of the opossum in the state, the majority of reports available to him coming from the lower valleys of the Arkansas, Republican, Arikaree, and South Platte rivers. He concluded that the species was fairly well established in the state. Beidleman (1952) estimated that the movement of appreciable numbers of opossums into Colorado began in the 1930's. According to reports of the Fur Division, Department of Game, Fish and Parks, 78 individuals were trapped in the lower Arkansas drainage from 1944 to 1947. The annual survey of the fur harvest, compiled from reports of fur dealers, indicates the following numbers of opossums taken during the years 1958 through 1967: 0, 3, 0, 0, 2, 4, 0, 3, 0, 0. Obviously, the opossum is not an important fur-bearer from an economic point of view.

The immigration and ecesis of the opossum in eastern Colorado has doubtless been facilitated by the development of agriculture in the region. The omnivorous habits of the species suit it for living near human settlement and croplands. The deciduous riparian woodland, important as cover for the opossum, has been favored by human interference, particularly in controlling fire and flood, and the control or extirpation of larger predators also may have favored the extension of range.

Although Colorado-taken museum specimens are few, the opossum is apparently common locally in the eastern part of the state. According to Wildlife Conservation Officer F. A. Scarpella of Wray, opossums are abundant in that area, and reports of damage to crops are received frequently from farmers. I have heard similar reports in the lower Arkansas River Valley. On the other hand, near the divide between the South Platte and Arkansas rivers, on Big Sandy Creek, residents of Ramah claimed never to have seen opossums and to have had no report of them from that area. Apparently, the greatest numbers occur in the major valleys near the eastern boundary of the state, and populations are sparse farther west. According to R. R. Lechleitner (personal communication) tracks have been seen around an irrigation reservoir south of Fort Collins, but to my knowledge no specimen has ever been preserved from that part of the state. A specimen (CU 1307) taken near Boulder in late November of 1919 may have escaped from captivity; tail and ears of the animal were badly damaged, the characteristic appearance of frost-bite.

Three opossums, a male and two females, were introduced in 1920 in Carpenter Wash, northwest of Grand Junction, by John D. Hart, formerly Assistant Director of the Colorado Department of Game and Fish. Other plants were made there in 1930 and 1940 (Remington, 1955; Hjelte, 1956). According to C. E. White (personal communication), game biologist for the Division of Game, Fish and Parks, the opossum still is present in Mesa County, but is not increasing to any extent.

Didelphis marsupialis virginiana Kerr

Didelphis virginiana Kerr, The animal kingdom. . . , p. 193, 1792; type locality, Virginia.

Didelphis marsupialis virginiana, Hall and Kelson, Univ. Kansas Publ., Mus. Nat. Hist., 5:322, 5 December 1952.

Distribution in Colorado.—Riparian communities along major rivers of eastern two-fifths of state; introduced in vicinity of Grand Junction (Fig. 9).

Measurements.—External and cranial measurements of a young adult male (CSU 9133) from Yuma County are: 574, 259, 44, 31; condylobasal length, 108.3; zygomatic breadth, 57.3; interorbital constriction, 19.9; postorbital constriction, 12.7; length of maxillary toothrow, 43.7; length of nasals, 49.8.

Records of occurrence.—Specimens examined, 3, distributed as follows: BOULDER COUNTY: Green Mountain Cemetery, Boulder, 1 (CU). YUMA COUNTY: state line west of St. Francis, Kansas, 1 (CSU). No precise locality: *Arkansas Valley,* 1 (CSU).

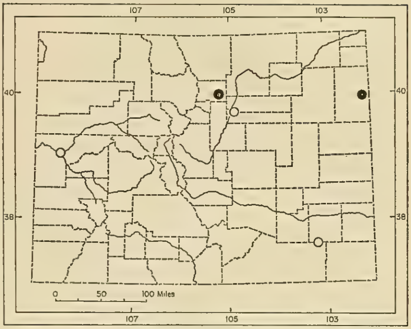


FIG. 9. Distribution of *Didelphis marsupialis virginiana* in Colorado. For explanation of symbols, see p. 9.

Additional records: DENVER COUNTY: Denver (Gruchy, 1950:76). MESA COUNTY: Carpenter Wash, NW of Grand Junction (Remington, 1955:43 —introduced, see above). BENT COUNTY: head of Caddoa Creek (Cary, 1911:52).

Order INSECTIVORA

The order Insectivora is represented in Colorado by two families. A single species of the Talpidae, *Scalopus aquaticus,* is confined to floodplains of rivers in the eastern part of the state. The family Soricidae is represented by five genera and nine species. For detailed habitat preferences of sympatric species of shrews in the Southern Rocky Mountains, see Spencer and Pettus (1966) and L. N. Brown (1967b). Lange (1959) discussed ecological distribution of shrews in Arizona.

The largest collections of Coloradan shrews made to date were accumulated by students in field biology at Colorado College under Dr. B. H. Banta. From 1963 to 1965, extensive altitudinal transects of pit-fall sampling stations were established in Teller, El Paso, Fremont, and Custer counties. Through the courtesy of Dr. Banta, now of United States International University, San Diego, California, and Mr. E. J. Pokropus of Colorado Springs, many of the specimens obtained from these transects have been deposited in the

Museum of Natural History of the University of Kansas. A preliminary report of shrews from a transect from the Arkansas River to Silver Cliff (Colorado Highway 277) was made by Pokropus and Banta (1965). A second transect was made in Phantom Canyon (Colorado Highway 76), along Eightmile Creek, from Victor to the Arkansas River. Armstrong *et al.* (1972) discussed altitudinal distribution of small mammals collected along the two transects in the Arkansas Valley. A third transect from which specimens are available was made in the Black Forest of El Paso County.

KEY TO SPECIES OF INSECTIVORA IN COLORADO

1. Zygomatic arch complete, condylobasal length more than 30; forefeet modified for digging .... *Scalopus aquaticus*

   Zygomatic arch incomplete, condylobasal length less than 23; forefeet not modified for digging 2

2. Total teeth 28, three unicuspids in each maxillary toothrow .... *Notiosorex crawfordi*

   Total teeth 30 or 32, four or five unicuspids in each maxillary toothrow 3

3. Length of tail greater than one-third total length 4

   Length of tail less than one-third total length 9

4. Third and fifth unicuspids minute, barely or not at all visible in lateral view .... *Microsorex hoyi*

   Four or five unicuspids visible in lateral view 5

5. Condylobasal length 20 or more; length of hind foot more than 18, hind foot fringed with stiff hairs; dorsal color grayish black .... *Sorex palustris*

   Condylobasal length 18 or less; length of hind foot 14 or less, hind foot not fringed with stiff hairs; dorsal color variously brownish, never black 6

6. Third unicuspid obviously smaller than fourth 7

   Third and fourth unicuspids of approximately equal size 8

7. Condylobasal length more than 15.8; braincase convex in lateral view; length of hind foot 12 or more, total length usually 100 or more .... *Sorex vagrans*

   Condylobasal length less than 15.0; braincase conspicuously flattened; length of hind foot 11 or less, total length usually less than 100 .... *Sorex nanus*

8. Unicuspid teeth markedly robust, maxillary toothrow crowded; braincase and interorbital region broad, rostrum truncate; maxillary breadth 5.0 or more; underparts whitish .... *Sorex merriami*

   Unicuspid teeth not robust, maxillary toothrow not conspicuously crowded; braincase and interorbital region relatively narrow, rostrum attenuate; maxillary breadth 4.5 or less; underparts variously brownish to buffy, not whitish .... *Sorex cinereus*

9. Total number of teeth 30, condylobasal length less than 16; total length less than 90 .... *Cryptotis parva*

   Total number of teeth 32, condylobasal length greater than 20; total length greater than 100 .... *Blarina brevicauda*

Family SORICIDAE—Shrews

Sorex cinereus

MASKED SHREW

Sorex cinereus is the most abundant shrew throughout much of mountainous central Colorado. Altitudinal range of specimens examined is from about 5,000 feet in Larimer County to approximately 11,000 feet in Boulder County, but Warren (1942:9) reported a specimen from the Summit House on Pikes Peak (14,100 feet). The masked shrew ranges to lower elevations in Colorado than does *Sorex vagrans*, but Spencer and Pettus (1966) found habitat preferences of the two species similar in western Larimer County; greatest numbers of both species were captured in wet meadows and willow thickets. Beidleman (1950) commented on the occurrence of *S. cinereus* on the plains immediately east of the Front Range. Although *S. cinereus* and *vagrans* generally are sympatric throughout

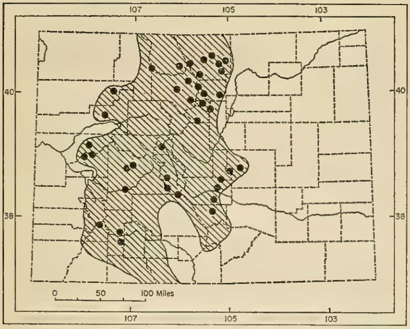


FIG. 10. Distribution of *Sorex cinereus cinereus* in Colorado. For explanation of symbols, see p. 9.

their ranges in Colorado, the former is more abundant on the Eastern Slope, in my experience, and *vagrans* is commoner west of the Continental Divide. My observations are supported by the fact that specimens of *cinereus* outnumbered those of *vagrans* by a ratio of three to one in samples from transects made in the vicinity of Cañon City by B. H. Banta and students from Colorado College.

Sorex cinereus is unknown in southwestern Colorado south of the Uncompahgre Plateau and west of the San Juan Mountains.

Sorex cinereus cinereus Kerr

Sorex arcticus cinereus Kerr, The animal kingdom. . . , p. 206, 1792; type locality, Fort Severn, Ontario.

Sorex cinereus cinereus, Jackson, Jour. Mamm., 6:56, 9 February 1925.

Distribution in Colorado.—Mesic habitats in and near the mountains and high plateaus of central and western parts of state (Fig. 10).

Comparison.—From *S. c. haydeni*, the subspecies of the northern Great Plains, *S. c. cinereus* differs in darker color and larger external and cranial size (see Jackson, 1928:51).

Measurements.—See table 1 for external and cranial measurements.

Remarks.—Comparison of Colorado-taken specimens of similar age suggests that there is no appreciable geographic variation within the state. Marked differences in color occur

TABLE 1

External and cranial measurements of three species of *Sorex*.

Catalog number, sex	Total length	Length of tail	Length of hind foot	Length of ear from notch	Greatest length of skull	Condylobasal length	Cranial breadth	Interorbital constriction	Maxillary breadth	Length of maxillary toothrow
Sorex cinereus cinereus, Chaffee and Lake counties										
KU 113599, ♀	90	44	12	5	16.6	15.6	7.9	2.8	4.2	5.8
KU 113600, ♀	90	37	12	6	16.5	15.3	7.1	2.9	4.2	5.8
2 1/2 mi. N, 2 1/2 mi. E Crestone, 8500 ft., Saguache County										
KU 120927, ♀	97	42	11	5	16.2	15.5	7.2	3.0	4.1	5.5
Sorex palustris navigator, Grand Mesa										
KU 59633, ♂	161	78	21	–	20.8	20.0	10.0	7.3	6.1	4.0
KU 59637, ♂	166	79	20	–	21.0	20.1	10.2	7.1	6.2	4.0
KU 59634, ♀	166	80	20	–	20.7	20.0	10.2	7.1	6.1	3.9
vicinity of Cucharas Camps, Huerfano County										
KU 59639, ♂	158	74	20	5	20.4	20.0	10.3	7.1	6.1	4.0
KU 59640, ♂	159	72	20	5	20.5	20.3	10.5	7.1	6.1	4.0
Sorex merriami leucogenys, Larimer and Boulder counties										
FLC (uncat.), ♂	88	31	12	6	16.6	15.8	8.2	4.1	5.0	5.9
CSU 12738, ♀	—	—	—	–	17.5	16.6	8.3	3.9	5.1	6.0
CU (uncat.), ?	90	35	12	–	16.1	15.2	7.9	3.5	5.0	6.1

with age, however, adults being considerably paler than younger animals.

Sorex cinereus presently is unknown from the plains of northeastern Colorado. It is, however, known to occur in Garden and Lincoln counties, Nebraska (Jones, 1964:63), and it is conceivable that this species will be taken in the drainage of the South Platte River in the extreme northeastern part of the state. Such a population probably would be allied with *S. c. haydeni.*

Warren (1908b:265) reported a shrew "identified by Dr. Merriam" as *Sorex personatus haydeni* from Lake Moraine, 10,250 feet, El Paso County. Two specimens from that locality presently are in the Warren Collection in the University of Colorado Museum. Both are within the range of variation of *S. c. cinereus* from elsewhere in the mountains of Colorado and are herein referred to that subspecies.

Records of occurrence.—Specimens examined, 219, distributed as follows: JACKSON COUNTY: Homestead Ranch, 1 (DMNH); Rabbit Ears Mountains, 1 (USNM). LARIMER COUNTY: sec. 2, T. 8 N, R. 71 W, 1 (CSU); *NW 1/4 sec. 17, T. 7 N, R. 72 W, 8680 ft.*, 1 (CSU); 1/2 mi. E Pennock Pass, 8680 ft., 1 (CSU); *Fort Collins,* 2 (CSU); *Poudre River, E of Fort Collins,* 2 (CSU); *1 mi. E Fort Collins,* 1 (CSU); *2 6/10 mi. E Fort Collins,* 2 (CSU); *3 mi. E Fort Collins,* 2 (CSU); 5 mi. E Fort Collins, 1 (CSU); *1/2 mi. N, 1/2 mi. E Poudre Valley Memorial Hospital, Fort Collins,* 1 (CSU); *1/2 mi. S, 1/2 mi. E Fort Collins, 4950 ft.*, 2 (CSU); *1/2 mi. S, 1 1/4 mi. E Fort Collins,* 1 (CSU); *1/2 mi. S, 1 1/2 mi. E Fort Collins,* 1 (CSU); *3 mi. ESE Fort Collins,* 1 (CSU); Trap Park, 2 (CSU); *Corral Park, 15 mi. E Gould,* 1 (CSU); 1/4 mi. SE Spring Canyon Dam, 1 (CSU); *North Fork Ranger Station,* 1 (RMNP); Loveland, 1 (USNM); *1/4 mi. above Hidden Valley Lodge,* 1 (RMNP); *Bear Lake,* 2 (DMNH); *Moraine Park,* 1 (RMNP); *Buck Creek,* 1 (RMNP); *4 mi. SW Estes Park,* 1 (RMNP); 3 1/2 mi. S, 4 mi. W Estes Park, 1 (KU). RIO BLANCO COUNTY: 9 1/2 mi. SW Pagoda Peak, 7700 ft., 2 (KU). GARFIELD COUNTY: Mud Springs, 8850 ft., 1 (WC). GRAND COUNTY: 2 1/2 mi. S, 2 mi. W Grand Lake, 2 (UNM); 2 mi. W Parshall, 1 (CU); *1/4 mi. NE Fraser,* 1 (CSU); Fraser Experimental Forest, 10 (CSU). BOULDER COUNTY: Buchanan Pass, 3 (USNM); *1 mi. NE Ward, 10,000 ft.*, 1 (KU); *Science Lodge,* 2 (CU); *below Niwot Ridge,* 1 (FMNH); 7 *mi.* NW Nederland, 1 (UMMZ); *4 mi. N, 1 mi. W Nederland,* 1 (FHSC); *Boulder Lake,* 2 (FWS); Boulder, 28 (13 FMNH, 7 USNM, 8 WC); 1/2 mi. W Valmont, 1 (CU); *Nederland,* 1 (CU); *Eldora,* 1 (FMNH). GILPIN COUNTY: 4 mi. S Nederland, 1 (CU); Blackhawk, 1 (USNM). CLEAR CREEK COUNTY: Mount Evans, 2 (CU); *no locality other than county,* 3 (DMNH). MESA COUNTY: Collbran, 1 (CU). LAKE COUNTY: 8 mi. SW Leadville, 10,000 ft., 1 (KU). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 10,200 ft., 1 (KU); 1/2 mi. S, 8 mi. E Skyway, 9500 ft., 2 (KU). GUNNISON COUNTY: near Gothic, 9500 ft., 7 (ANSP); Irwin, 2 (WC); 9 mi. E Gunnison, 8200 ft., 1 (CSU). CHAFFEE COUNTY: St. Elmo, 8 (USNM); 17 mi. W Salida, 11,000 ft., 2 (CM); Poncha Creek, 10 mi. SW Salida, 8500 ft., 2 (KU). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 1 (FWS); Eightmile Creek, 10,201 ft., 1 (KU); *Eightmile Creek, 9701 ft.*, 1 (KU); *Eightmile Creek, 9685 ft.*, 1 (KU); *Eightmile Creek, 9655 ft.*, 1 (KU); *Eightmile Creek, 8200 ft.*, 3 (KU); *Eightmile Creek, 9455 ft.*, 1 (KU); *Eightmile Creek, 9165 ft.*, 2 (KU). EL PASO COUNTY: Black Forest, 13 (KU); Lake Moraine, 10,250 ft., 2 (WC); *Halfway,* 1 (UMMZ). MONTROSE COUNTY: sec. 15, T. 47 N, R. 12 W, 13 mi. N, 7 mi. E Norwood, 8400 ft., 1 (KU). SAGUACHE COUNTY: 2 mi. N, 2 1/2 mi. E Crestone, 8500 ft., 1 (KU). FREMONT COUNTY: *Eightmile Creek, 8690 ft.*, 1 (KU); *Eightmile Creek, 8470 ft.*, 1 (KU); *Eightmile Creek, 8400 ft.*, 3 (KU); *Eightmile Creek, 7990 ft.*, 1 (KU); *Eightmile Creek, 7925 ft.*, 1 (KU); *Eightmile Creek, 7840 ft.*, 1 (KU); *Eightmile Creek, 7550 ft.*, 1 (KU); *Eightmile Creek, 7360 ft.*, 1 (KU); *Eightmile Creek, 6990 ft.*, 1 (KU); *Eightmile Creek, 6960 ft.*, 2 (KU); *Eightmile Creek, 6780 ft.*, 2 (KU); *Eightmile Creek, 6365 ft.*, 3 (KU); *Eightmile Creek, 6295 ft.*, 1 (KU); *Eightmile Creek, 6070 ft.*, 1 (KU); Eightmile Creek, 5660 ft., 1 (KU); *22 mi. (by road) NE Silver Cliff, 6680 ft.*, 1 (KU); *20 2/10 mi. (by road) NE Silver Cliff, 6900 ft.*, 1 (KU); *19 8/10 mi. (by road) NE Silver Cliff, 6900 ft.*, 4 (KU); *19 4/10 mi. (by road) NE Silver Cliff, 7100 ft.*, 4 (KU); *19 mi. (by road) NE Silver Cliff, 7400 ft.*, 2 (KU); *18 6/10 mi. (by road) NE Silver Cliff, 7200 ft.*, 2 (KU); *18 2/10 mi. (by road) NE Silver Cliff, 7300 ft.*, 2 (KU); *17 8/10 mi. (by road) NE Silver Cliff, 7400 ft.*, 5 (KU); *17 4/10 mi. (by road) NE Silver Cliff, 7500 ft.*, 4 (KU); *17 mi. (by road) NE Silver Cliff, 7590 ft.*, 4 (KU); *14 8/10 mi. (by road) NE Silver Cliff, 7800 ft.*, 2 (KU). CUSTER COUNTY: *12 mi. (by road) NE Silver Cliff, 8100 ft.*, 1 (KU); *11 2/10 mi. (by road) NE Silver Cliff, 8200 ft.*, 1 (KU); *10 8/10 mi. (by road) NE Silver Cliff, 8200 ft.*, 1 (KU); *10 mi. (by road) NE Silver Cliff, 7987 ft.*, 1 (KU); *9 6/10 mi. (by road) NE Silver Cliff, 7989 ft.*, 1 (KU); *9 2/10 mi. (by road) NE Silver Cliff, 8000 ft.*, 4 (KU); *6 8/10 mi. (by road) NE Silver Cliff, 8200 ft.*, 4 (KU); *5 2/10 mi. (by road) NE Silver Cliff, 8000 ft.*, 1 (KU); *2 8/10 mi. (by road) NE Silver Cliff, 8013 ft.*, 1 (KU); *2 mi. (by road) NE Silver Cliff, 7950 ft.*, 1 (KU); *8/10 mi. (by road) NE Silver Cliff, 7900 ft.*, 1 (KU); 4/10 mi. (by road) NE Silver Cliff, 7900 ft., 1 (KU). OURAY COUNTY: Red Mountain Pass, 2 (SC). HINSDALE COUNTY: Hermit, 1 (USNM); Ruby Lake, 1 (USNM). CONEJOS COUNTY: Platoro, 1 (FHSC); *"3-5 mi. SW Platoro,"* 1 (FHSC).

Additional records (Jackson, 1928:47, unless otherwise noted): JACKSON COUNTY: Pearl, 9000 ft.; Arapaho Pass; [near] Lake Agnes (Yeager, 1950:329). RIO BLANCO COUNTY: Marvine Lodge (Felger, 1910:146). GARFIELD COUNTY: Trappers Lake (Yeager, 1950:329). GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53). BOULDER COUNTY: Dixie Lake. GILPIN COUNTY: Moon Gulch (Williams, 1955b:224). PARK COUNTY: Mount Bross. GUNNISON COUNTY: Gothic Natural Area, 2 mi. NW Gothic, 10,200 ft. (Findley and Negus, 1953:237). EL PASO COUNTY: Summit House, Pikes Peak (Warren, 1942:9).

Sorex vagrans

Wandering Shrew

The wandering shrew is common in mesic situations in the mountains of the western three-fifths of Colorado. *Sorex vagrans* may be abundant locally, and marked fluctuations in populations have been reported. Spencer and Pettus (1966:680) found synchronous fluctuations in sympatric populations of *S. vagrans* and *cinereus* in western Larimer County, and suggested that either the populations were being influenced by the same extrinsic factor or the populations were influencing each other.

The preferred habitat of *S. vagrans* is similar to that of *S. cinereus,* although the wandering shrew does not typically range to the low elevations frequented by *S. cinereus* east of the Front Range. The altitudinal range of specimens examined was from 5300 feet to 11,400 feet, with both extremes in Boulder County.

Sorex vagrans obscurus Merriam

Sorex vagrans similis Merriam, N. Amer. Fauna, 5:34, 30 July 1891; type locality, Timber Creek, 8200 ft., Salmon River [Lemhi] Mountains [10 mi. W Junction, Lemhi Co.], Idaho. Not *Sorex similis* Hensel, 1855.

Sorex obscurus Merriam, N. Amer. Fauna, 10:72, 31 December 1895 (a renaming of *Sorex vagrans similis* Merriam).

Sorex vagrans obscurus, Findley, Univ. Kansas Publ., Mus. Nat. Hist., 9:43, 10 December 1955.

Distribution in Colorado.—Mesic habitats in mountains and on high plateaus and mesas of central and western parts of state (Fig. 11).

Comparison.—From *S. v. monticola,* the subspecies of eastern Arizona and western New Mexico, *S. v. obscurus* differs in larger size both externally and cranially.

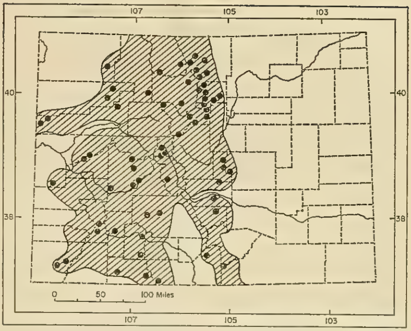


FIG. 11. Distribution of *Sorex vagrans obscurus* in Colorado. For explanation of symbols, see p. 9.

Measurements.—External and cranial measurements of several samples of *S. vagrans* are presented in table 2.

Remarks.—Findley (1955) referred all specimens of *S. vagrans* from Colorado known to him to the subspecies *S. v. obscurus.* At that time the species had not been collected in extreme southwestern Colorado; Silverton and Navajo River were cited as marginal records of the subspecies (*op. cit.*:48). Subsequently, a small series of specimens was reported from Mesa Verde National Park, Montezuma County, by Anderson (1961:37), who commented on the small average size of certain cranial measurements, intermediate between those of *S. v. obscurus* and *S. v. monticola.* It seems reasonable to follow Anderson in considering southwestern Colorado as an area of intergradation, or at least of intermediacy, between the subspecies *obscurus* and *monticola.* I also follow Anderson (*op. cit.* :37) in referring specimens from Mesa Verde to *obscurus* on geographic grounds, inasmuch as they are nearer to populations of *obscurus* in the San Juan Mountains of Colorado than to those of *monticola* of the Chuska Mountains of New Mexico.

Warren (1942:9) referred a single specimen from Lake Moraine, El Paso County, to *S. v. monticola.* Earlier, Warren (1906:266) had referred the specimen to *S. v. dobsoni* (=*S. v. vagrans*), noting that it was identified for him by the Bureau of Biological Surveys in 1905. Four specimens from Lake Moraine

TABLE 2

External and cranial measurements of four populations of *Sorex vagrans obscurus.*

Number averaged (or catalog number), sex	Total length	Length of tail	Length of hind foot	Length of ear from notch	Condylo-basal length	Cranial breadth	Interorbital constriction	Maxillary breadth	Length of maxillary toothrow
Boulder and Larimer counties									
KU 74556, ♂	108	43	12	7	16.4	8.5	4.1	4.9	6.0
KU 50310, ♂	114	48	13	7	17.8	8.8	4.2	5.2	6.4
Mean, 6 ♀	103.5	45.8	12.8	7.7	17.27	8.43	4.10	4.98	6.43
Minimum	95	43	12	7	16.7	8.2	3.9	4.8	6.2
Maximum	116	49	13	8	17.5	8.8	4.3	5.2	6.6
Rio Blanco and Garfield counties									
Mean, 4 ♂	109.2	45.0	12.5	7.2	17.26	8.84	4.04	5.10	6.50
Minimum	105	42	12	7	17.2	8.5	3.9	5.0	6.4
Maximum	114	47	13	8	17.3	9.1	4.1	5.2	6.6
KU 19934, ♀	109	47	13	7	17.5	8.8	4.1	5.1	6.6
vicinity of Cucharas Camps, Huerfano County									
Mean, 5 ♂	107.0	44.0	12.6	—	16.74	8.64	3.94	4.94	6.12
Minimum	104	43	12	—	16.5	8.5	3.7	4.8	6.0
Maximum	109	45	13	—	17.4	8.8	4.2	5.2	6.3
Mean, 6 ♀	107.5	42.7	12.3	8.0	16.72	8.38	4.00	4.90	6.18
Minimum	102	40	12	7	16.4	8.2	3.9	4.8	6.0
Maximum	113	44	13	9	17.0	8.6	4.1	5.0	6.4
vicinity of Mesa Verde National Park, Montezuma County									
KU 75971, ?	101	44	13	8	16.5	8.5	4.0	5.2	6.6
KU 75973, ?	106	42	13	7	16.9	8.6	3.7	5.0	6.6
KU 69238, ♂	104	42	14	—	16.5	8.6	3.8	5.2	6.3
KU 69240, ♂	110	46	13	—	—	—	3.6	4.9	6.3
KU 69239, ♀	114	47	13	—	16.7	8.5	3.6	5.0	6.3

presently are in the Warren Collection in the University of Colorado Museum; all fall within the range of variation of *S. v. obscurus* as currently understood. Von Bloeker (1944:312) reported a specimen from Loveland Pass, 12,000 feet, as *monticola.* The record is herein referred to *obscurus* on geographic grounds.

Records of occurrence.—Specimens examined, 365, distributed as follows: MOFFAT COUNTY: 1/2 mi. S Craig, 1 (CSU). ROUTT COUNTY: Gore Range, 8 mi. E Toponas, 8000 ft., 1 (USNM). JACKSON COUNTY: 2 mi. N, 2 mi. E Gould, 8600 ft., 1 (KU); Arapaho Pass, 2 (USNM). LARIMER COUNTY: Sevenmile Creek, 35 mi. NW Fort Collins, 1 (CSU); 1 mi. S, 11 mi. W Rustic, 1 (KU); *Cache la Poudre River,* 1 (KU); Chambers Lake, 9500 ft., 3 (CSU); Little Beaver Creek, sec. 36, T. 8 N, R. 73 W, 7800 ft., 1 (CSU); 8 mi. WNW Estes Park, 1 (FHSC); Willow Park, Rocky Mountain National Park, 8 (UMMZ); 3 mi. E Estes Park, 2 (CSU); Bear Lake, 3 (DMNH); *3 1/2 mi. S, 4 mi. W Estes Park,* 3 (KU); *Longs Peak,* 1 (USNM). RIO BLANCO COUNTY: 9 1/2 mi. SW Pagoda Peak, 7700 ft., 2 (KU); Marvine Lodge, 1 (CU); *8 mi. SE South Fork Campground, 10,860 ft.,* 1 (CSU). GARFIELD COUNTY: Deep Lake, 16 mi. N Glenwood Springs, 3 (KU); head of Douglas Creek, 30 mi. S Rangely, 8000 ft., 1 (AMNH); Baxter Pass, 8500 ft., 1 (USNM). GRAND COUNTY: *2 mi. S, 2 mi. W Grand Lake, 8368 ft.,* 1 (UNM); Williams Fork, 22 mi. S Parshall, 2 (CU). SUMMIT COUNTY: near Sheephorn Pass, 2 (WC); Hoosier Pass, 2 (DMNH). BOULDER COUNTY: 3/4 mi. N, 2 mi. W Allenspark, 8400 ft., 6 (KU); Buchanan Pass, 11,000 ft., 1 (USNM); Ward, 9500 ft., 1 (USNM); *Niwot Ridge, 11,400 ft.,* 1 (CU); *Science Lodge,* 2 (CU); Silver Lake, 4 (DMNH); *3 mi. S Ward,* 1 (KU); *7 mi. NW Nederland,* 1 (UMMZ); *6 mi. NW Nederland,* 6 (CU); *5 mi. W Boulder,* 3

(USNM); Boulder, 3 (2 FMNH, 1 USNM); *mouth of Gregory Canyon,* 1 (CU); *Gregory Canyon,* 1 (CU); Nederland, 17 (3 ANSP, 7 FMNH, 5 USNM, 2 WC); *E slope Mt. Sanitas,* 5 (3 CSU, 2 CU); *Eldora,* 2 (1 CU, 1 USNM); Dixie Lake, 1 (DMNH); 3 mi. E Pinecliff, 4 (DMNH); *no locality other than county,* 9 (USNM). GILPIN COUNTY: *4 mi. S Nederland,* 1 (CU); Tolland, 1 (CU); *Dory Hill Pond,* 1 (USNM); Blackhawk, 1 (ANSP). CLEAR CREEK COUNTY: Idaho Springs, 7500 ft., 1 (KU); Loveland Pass, 1 (FWS); Mt. McClellan, 11,000 ft., 2 (USNM); Mt. Evans, 1 (CU); *no locality other than county,* 9 (7 DMNH, 2 UI). MESA COUNTY: *Grand Mesa,* 1 (CSU); Uncompahgre Butte, 8500 ft., 3 (USNM). LAKE COUNTY: Halfmoon Creek, 8 mi. SW Leadville, 10,000 ft., 4 (KU); 12 mi. S, 1 mi. W Leadville, 1 (KU); 3 mi. W Twin Lakes, 2 (KU). PARK COUNTY: 8 mi. NNW Grant, 10,000 ft., 5 (FWS). DELTA COUNTY: 12 mi. S, 5½ mi. E Collbran, 10,200 ft., 6 (KU); *1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 4 (KU); *1 mi. S, 8 mi. E Skyway, 10,200 ft.,* 1 (KU); *1 1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 3 (KU); 2 mi. S, 8 mi. E Skyway, 9000 ft., 1 (KU). GUNNISON COUNTY: *Copper Lake,* 3 (UNM); 2 mi. N Gothic, 1 (UNM); *2 mi. W Gothic,* 1 (UNM); *Gothic,* 7 (UNM); Crested Butte, 5 (WC); Almont, 2 (USNM); 12 mi. N Gunnison, 1 (WSC); 3 mi. N Gunnison, 7790 ft., 1 (CSU); *8 mi. NW Sapinero,* 1 (USNM); *33 mi. W Gunnison,* 1 (CM); 7 1/2 mi. W Gunnison, 7200 ft., 2 (FWS); 9 mi. WNW Sapinero, 9500 ft., 1 (KU); 10 mi. SSE Gunnison, 8500 ft., 2 (FWS). CHAFFEE COUNTY: St. Elmo, 10,100 ft., 2 (USNM); *W end Chubb's Park,* 1 (CSU); Salida, 1 (WC); E side Monarch Pass, 17 mi. W Salida, 11,000 ft., 3 (CM); *8 mi. SW Salida, 9500 ft.,* 7 (KU); Poncha Pass, 1 (WC). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 3 (FWS); Manitou Experimental Forest, 1 (CSU); Glen Cove, 2 (UMMZ); Eightmile Creek, 10,201 ft., 1 (KU); *Eightmile Creek, 9860 ft.,* 6 (KU); *Eightmile Creek, 9701 ft.,* 3 (KU); *Eightmile Creek, 9510 ft.,* 1 (KU); *Eightmile Creek, 9085 ft.,* 1 (KU). EL PASO COUNTY: *above Manitou,* 1 (WC); *near Colorado Springs,* 1 (WC); *Hunters Creek, tributary of Bear Creek,* 1 (AMNH); Lake Moraine, 5 (1 MCZ, 4 WC); *E end Strickler Tunnel* (not found), 1 (WC). MONTROSE COUNTY: SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft., 4 (KU); sec. 15, T. 47 N, R. 12 W, 13 mi. N, 7 mi E Norwood, 8400 ft., 3 (KU). OURAY COUNTY: Red Mountain Pass, 13 (SC). SAGUACHE COUNTY: 3 mi. N, 16 mi. W Saguache, 8500 ft., 2 (KU); Cochetopa Pass, 33 mi. W Saguache, 10,000 ft., 4 (KU); *Monshower Meadows, 3 mi. E Cochetopa Pass,* 2 (USNM). FREMONT COUNTY: *Eightmile Creek, 8930 ft.,* 1 (KU); *Eightmile Creek, 8690 ft.,* 1 (KU); *Eightmile Creek, 8560 ft.,* 1 (KU); *Eightmile Creek, 8470 ft.,* 1 (KU); *Eightmile Creek, 8340 ft.,* 3 (KU); *Eightmile Creek, 7840 ft.,* 3 (KU); *Eightmile Creek, 6990 ft.,* 1 (KU); Eightmile Creek, 6880 ft., 1 (KU); *19 4/10 mi. (by road) NE Silver Cliff, 7100 ft.,* 1 (KU); *17 4/10 mi. (by road) NE Silver Cliff, 7500 ft.,* 1 (KU). CUSTER COUNTY: 9 2/10 mi. (by road) NE Silver Cliff, 8000 ft., 1 (KU). DOLORES COUNTY: sec. 13, T. 40 N, R. 14 W, 9000 ft., 4 (KU). SAN JUAN COUNTY: Silverton, 4 (USNM). HINSDALE COUNTY: Hermit, 1 (USNM). MINERAL COUNTY: 4 mi. S, 6 mi. E Wagon Wheel Gap, 8500 ft., 1 (KU); Windy Mountain, 11,000 ft., 1 (UI); 23 mi. S, 11 mi. E Creede, 9300 ft., 1 (KU). RIO GRANDE COUNTY: 8 mi. S, 11 mi. W Monte Vista, 7660 ft., 4 (UI); Blowout Pass [4 mi. N Jasper], 11,500 ft., 1 (UI). HUERFANO COUNTY: 4 mi. S Cucharas Camps, 4 (KU); *5 mi. S, 1 mi. W Cucharas Camps,* 10 (KU). MONTEZUMA COUNTY: 1 mi. W Mancos, 7000 ft., 1 (KU); *Upper Well, Prater Canyon, Mesa Verde National Park, 7575 ft.,* 3 (KU); *1/4 mi. N Middle Well, Prater Canyon, 7500 ft.,* 2 (KU); Morfield Canyon, 7600 ft., 2 (KU). ARCHULETA COUNTY: Navajo River, 6 (DMNH); 1/2 mi. N, 2 mi. E Chimney Rock, 1 (UNM). CONEJOS COUNTY: Platoro, 8 (FHSC); *1 mi. SW Platoro,* 1 (FHSC); *"3-5 mi. SW Platoro,"* 18 (FHSC); 5 mi. S, 24 mi. W Antonito, 9600 ft., 1 (KU). COSTILLA COUNTY: *[near] Fort Garland,* 2 (USNM).

Additional records: JACKSON COUNTY: *[near] Lake Agnes* (Yeager, 1950:329). GARFIELD COUNTY: *Trappers Lake* (Yeager, *loc. cit.*). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). BOULDER COUNTY: *1/4 mi. SW Sunset* (Williams, 1955a:42). GILPIN COUNTY: *Jumbo Mountain* (Williams and Finney, 1967:74); *Moon Gulch* (Williams, 1955b:224). CLEAR CREEK COUNTY: *Upper Clear Creek* (F. W. Miller, 1930b:311). PARK COUNTY (Blake and Blake, 1969:37): *Mount Lincoln, 11,200 ft.; Mount Lincoln, 13,100 ft.; Montgomery.* GUNNISON COUNTY: *Gothic Natural Area, 2 mi. NW Gothic, 10,200 ft.* (Findley and Negus, 1953:237); *East River, 6/10 mi. NW Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *1/2 mi. above mouth of Willow Creek* (Durrant and Robinson, 1962:239); *Dry Gulch at Gunnison River, 7380 ft.* (Durrant and Robinson, *loc. cit.*). CHAFFEE COUNTY: *7 mi. W Salida* (Findley, 1955:47). MONTEZUMA COUNTY: *Mug House, Wetherill Mesa, Mesa Verde National Park* (Hoffmeister, 1967:462). COSTILLA COUNTY: *near Blanca* (from owl pellet—Longhurst, 1942:282).

Sorex nanus

Dwarf Shrew

The dwarf shrew generally has been considered to be rare in Colorado. Cary (1911: 203) emphasized this, commenting that ". . . not one was captured in my three seasons' work on all the higher mountain ranges of the State." Nonetheless, a relatively large number of specimens has been obtained in recent years. Spencer and Pettus (1966), for example, reported a collection of 24 specimens

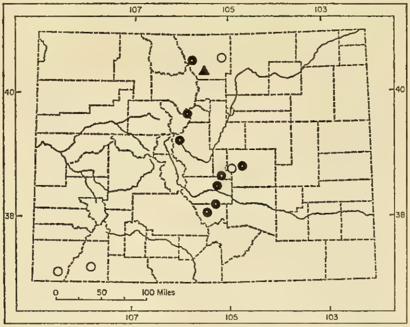


Fig. 12. Distribution of *Sorex nanus* in Colorado. For explanation of symbols, see p. 9.

from western Larimer County, the shrews having been captured in sunken one-gallon paint cans that had been set out in conjunction with a study of the chorus frog, *Pseudacris triseriata.* The largest series available were obtained by B. H. Banta and students from Colorado College in the course of pit-fall sampling in the vicinity of Cañon City.

Sorex nanus was long supposed to be restricted to the higher mountains, but a recent record from Soldier Canyon Dam, south of Bellvue at about 5500 feet, casts doubt on this supposition. Specimens from transects near Cañon City have an altitudinal range from about 6200 to nearly 9800 feet. Spencer and Pettus (1966) found *S. nanus* to occupy drier sites than *S. cinereus, S. vagrans, S. palustris,* or *Microsorex hoyi* on a study area at about 9700 feet in the upper Cache la Poudre drainage. In the Medicine Bow Mountains of southern Wyoming, L. N. Brown (1967b) found the dwarf shrew most abundant in alpine and subalpine rockslides.

Sorex nanus Merriam

Sorex tenellus nanus Merriam, N. Amer. Fauna, 10:81, 31 December 1895; type locality, Estes Park, Larimer Co., Colorado.

Sorex nanus, Jackson, N. Amer. Fauna, 51:174, 24 July 1928.

Distribution in Colorado.—Known from scattered localities in mountains and foothills of central and southwestern parts of state (Fig. 12).

Measurements.—External measurements of the holotype (USNM 73773, a male), and those of two males from western Larimer County are, respectively: 105, 89, 97; 42, 40, 39; 10, 11, 10. Representative cranial measurements of the holotype and a young adult of unknown sex from Custer County are: condylobasal length, —, 14.5; cranial breadth, 5.3, 5.4; interorbital constriction, 3.0, 3.0; maxillary breadth, 4.0, 4.0; length of maxillary toothrow, 5.1, 5.2 (Jackson, 1928:174).

Remarks.—Specimens of *S. nanus* are easily confused with other kinds of Coloradan shrews, particularly *S. vagrans,* from which they differ principally as follows: condylobasal length less than 15.0; length of body less than 55; hind foot less than 12; teeth smaller, less heavily pigmented; length of nonmolariform toothrow, less than 2.2 (see A. W. Spencer, 1966).

Records of occurrence.—Specimens examined, 90, distributed as follows: LARIMER COUNTY: Lily Pond, 2 mi. S Chambers Lake, 6 (FLC); sec. 1, T. 7 N, R. 70 W, 1 mi. S Bellvue, 1 (FLC); Estes Park, 1 (USNM). CLEAR CREEK COUNTY: Camp Lemon, 5 mi. above Silverplume, 3 (DMNH). PARK COUNTY: Alma, 1 (DMNH). TELLER COUNTY: Eightmile Creek, 9780 ft., 1 (KU); *Eightmile Creek, 9701 ft.*, 1 (KU); *Eightmile Creek, 9655 ft.*, 1 (KU); *Eightmile Creek, 9345 ft.*, 1 (KU); *Eightmile Creek, 9245 ft.*, 1 (KU); *Eightmile Creek, 9205 ft.*, 3 (KU); *Eightmile Creek, 9165 ft.*, 3 (KU); *Eightmile Creek, 9125 ft.*, 1 (KU); *Eightmile Creek, 9010 ft.*, 3 (KU). EL PASO COUNTY: Black Forest, 4 (KU). FREMONT COUNTY: *Eightmile Creek, 8930 ft.*, 1 (KU); *Eightmile Creek, 8810 ft.*, 1 (KU); *Eightmile Creek, 8690 ft.*, 2 (KU); *Eightmile Creek, 8650 ft.*, 1 (KU); *Eightmile Creek, 8560 ft.*, 3 (KU); *Eightmile Creek, 8400 ft.*, 1 (KU); *Eightmile Creek, 8075 ft.*, 1 (KU); *Eightmile Creek, 7990 ft.*, 1 (KU); *Eightmile Creek, 7925 ft.*, 1 (KU); *Eightmile Creek, 7840 ft.*, 2 (KU); *Eightmile Creek, 7745 ft.*, 1 (KU); *Eightmile Creek, 7550 ft.*, 2 (KU); *Eightmile Creek, 7440 ft.*, 7 (KU); *Eightmile Creek, 7360 ft.*, 7 (KU); *Eightmile Creek, 6960 ft.*, 7 (KU); *Eightmile Creek, 7290 ft.*, 3 (KU); *Eightmile Creek, 7170 ft.*, 2 (KU); *Eightmile Creek, 6990 ft.*, 2 (KU); *Eightmile Creek, 6737 ft.*, 1 (KU); *Eightmile Creek, 6000 ft.*, 2 (KU); Eightmile Creek, 6170 ft., 2 (KU); *19 8/10 mi. (by road) NE Silver Cliff, 6900 ft.*, 1 (KU); 19 4/10 mi. (by road) NE Silver Cliff, 7100 ft., 1 (KU); *17 4/10 mi. (by road) NE Silver Cliff, 7500 ft.*, 3 (KU). CUSTER COUNTY: *12 4/10 mi. (by road) NE Silver Cliff, 8000 ft.*, 2 (KU); 12 mi. (by road) NE Silver Cliff, 8100 ft., 1 (KU); 10 mi. (by road) NE Silver Cliff, 7987 ft., 2 (KU); *9 2/10 mi. (by road) NE Silver Cliff, 8000 ft.*, 1 (KU); *8 8/10 mi. (by* *road) NE Silver Cliff, 8100 ft.*, 1 (KU); Westcliffe, 1 (USNM).

Additional records: CLEAR CREEK COUNTY: *above Silverplume, 9000 ft.* (von Bloeker, 1944:312). EL PASO COUNTY: near Colorado Springs (Warren, 1942:11). MONTEZUMA COUNTY: Mug House, Wetherill Mesa, Mesa Verde National Park (Hoffmeister, 1967:462).

Sorex palustris

WATER SHREW

Sorex palustris occurs near water throughout the mountains of the western three-fifths of Colorado. Extremes of elevation of specimens examined are 6000 feet at Rifle Creek Hatchery, Garfield County, and 10,100 feet at St. Elmo, Chaffee County. The species no doubt occurs somewhat higher under suitable conditions. Water shrews are to be found most commonly along streams or ponds in dense spruce-fir forests, but may range down into open pine woodlands or even lower, given favorable microhabitat. These shrews are semi-aquatic and are excellent swimmers.

No detailed study of the natural history of *S. palustris* in Colorado has been made, but Spencer and Pettus (1966) compared habitat preferences of water shrews with those of four other species of long-tailed shrews in western Larimer County. Gordon (1931) discussed reproduction in the water shrew in Boulder County. Conaway (1952) reported on natural history of the species in Montana.

Sorex palustris navigator (Baird)

Neosorex navigator Baird, Mammals, *in* Reports of Explorations and Surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):11, 14 July 1858; type locality, near head of Yakima River, Cascade Mountains, Washington.

Sorex (Neosorex) palustris navigator, Merriam, N. Amer. Fauna, 10:92, 31 December 1895.

Distribution in Colorado.—Throughout the mountainous parts of the state in suitable habitat (Fig. 13).

Measurements.—External and cranial measurements are presented in table 1.

Remarks.—Long (1965:524) described microgeographic variation in *S. p. navigator* in Wyoming. Available material hints at such variation in Colorado also, but I have not examined series of sufficient size from local areas to describe such variation in any detail.

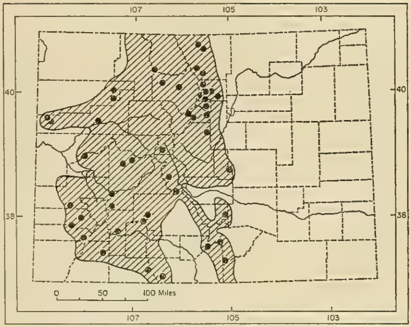


FIG. 13. Distribution of *Sorex palustris navigator* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 137, distributed as follows: JACKSON COUNTY: Grizzly Creek, 9000 ft., Rabbit Ears Pass, 1 (CSU). LARIMER COUNTY: North Lone Pine Creek, 3 mi. W Red Feather Lakes, 1 (USNM); Elkhorn, 7000 ft., 1 (USNM); Pingree Park, 1 (CSU); 3 mi. N, 3 mi. E Estes Park, 2 (FHSC); Willow Park, Rocky Mountain National Park, 1 (UMMZ); *Moraine Park, halfway up Fern Lake Trail*, 1 (RMNP); *SE end utility area, Buck Creek*, 1 (RMNP); *Mill Creek*, 1 (RMNP); *YMCA Camp, 3 mi. S, 3 mi. W Estes Park, 8000 ft.*, 1 (UI); 3 mi. S, 3 mi. W Estes Park, 1 (KU); *3 1/2 mi. S, 4 mi. W Estes Park*, 1 (KU). RIO BLANCO COUNTY: Ute Creek, 8000 ft., 16 (AMNH); Lost Creek, 9 mi. NE Buford, 1 (CM); Marvine, 1 (USNM). GARFIELD COUNTY: West Fork Douglas Creek, 8000 ft., 35 mi. S Rangely, 1 (CM); 28 mi. N, 5 mi. W Mack, 7250 ft., 1 (KU); Rifle Creek Hatchery, 6000 ft., 1 (CSU). GRAND COUNTY: 1/4 mi. S Hilltop Ranger Station, Grand Lake, 1 (RMNP); Cache River, 4 mi. N Stillwater, 1 (UI); 9 1/2 mi. N Kremmling, 1 (CU); 4 mi. SW Hot Sulphur Springs, 1 (CU). BOULDER COUNTY: 3/4 mi. N, 2 mi. W Allenspark, 1 (KU); near Ward, 1 (CU); *3 mi. S Ward*, 1 (KU); Gold Hill, 2 (USNM); 7 mi. NW Nederland, 1 (UMMZ); *Science Lodge*, 2 (CU); *4 4/10 mi. W Boulder*, 1 (CU); Boulder, 6 (2 ANSP, 3 FMNH, 1 USNM); *4 mi. N, 1 mi. W Nederland*, 1 (CU); Nederland, 4 (1 ANSP, 3 FMNH); *no locality other than county*, 1 (USNM). GILPIN COUNTY: Dory Hill Pond, Blackhawk, 3 (1 ANSP, 2 USNM). CLEAR CREEK COUNTY: *headwaters of Clear Creek*, 1 (SC); N side Idaho Springs, 1 (KU); *2 1/2 mi. W Silverplume*, 1 (SC); Camp Lemon, 5 mi. above Silverplume, 3 (DMNH); Silverplume, 1 (SC); Graymount, 1 (SC); *no locality other than county, 9000 ft.*, 1 (UI). LAKE COUNTY: Mount Elbert, 1 (USNM). PARK COUNTY: 8 mi. NNW Grant, 10,000 ft., 1 (FWS); Bailey, 1 (SC). DELTA COUNTY: *1/2 mi. S, 8 mi. E Skyway*, 1

(KU); *1 1/2 mi. S, 8 mi E Skyway, 9500 ft.*, 1 (KU); 2 mi. S, 8 mi. E Skyway, 9000 ft., 2 (KU); 2 1/2 mi. S, 8 mi. E Skyway, 9600 ft., 2 (KU). GUNNISON COUNTY: Gothic, 4 (2 UNM, 2 USNM); *near Gothic*, 1 (UMMZ); near Beckwith Pass, 2 (UNM); Almont, 2 (USNM); 33 mi. W Gunnison, 1 (CM). CHAFFEE COUNTY: St. Elmo, 10,100 ft., 4 (USNM); Poncha Creek, 10 mi. SW Salida, 8500 ft., 3 (KU). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 2 (FWS). EL PASO COUNTY: *Minnehaha*, 3 (UMMZ); Lake Moraine, 2 (1 CSU, 1 MCZ). MONTROSE COUNTY: SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft., 1 (KU); Maverick Canyon, 2 mi. N Coventry, 3 (USNM); *Uncompahgre National Forest*, 1 (SC). OURAY COUNTY: Red Mountain Pass, 1 (SC). SAN MIGUEL COUNTY: Placerville, 1 (SC). SAGUACHE COUNTY: Saguache Park, 2 (USNM); Cochetopa Pass, 1 (USNM). CUSTER COUNTY: 10 mi. W Beulah, 1 (UMMZ). DOLORES COUNTY: Lone Cone Peak, 3 (SC); Rico, 1 (USNM). HINSDALE COUNTY: Hermit, 3 (USNM). RIO GRANDE COUNTY: 8 mi. S, 11 mi. W Monte Vista, 2 (UI). HUERFANO COUNTY: Blanca Peak, 1 (CSU); La Veta Pass, 3 (AMNH); 5 mi. S, 1 mi. W Cucharas Camps, 3 (KU). LA PLATA COUNTY: 21 mi. N Bayfield, 1 (AMNH). ARCHULETA COUNTY: Navajo River, 3 (DMNH). CONEJOS COUNTY: 1/2 mi. N, 1 mi. W Platoro, 1 (KU); "*3-5 mi. SW Platoro*," 1 (FHSC); 12 mi. NE Cumbres, 1 (AMNH); 4 mi. S, 23 mi. W Antonito, 10,100 ft., 1 (KU).

Additional records: GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53); Middle Park (Jackson, 1928:188). GUNNISON COUNTY (Findley and Negus, 1953:237, unless otherwise noted): *East River, 6/10 mi. NW Gothic, 9600 ft.; Virginia Basin, 4/10 mi. NW Gothic, 9600 ft.; East River, 5/10 mi. S Gothic; Decker's Ranch, Crested Butte* (Jackson, 1928:188); *West Elk Creek, 1 mi. W Gunnison River, 7400 ft.* (Durrant and Robinson, 1962:239); Dry Gulch at Gunnison River (Durrant and Robinson, *loc. cit.*). COSTILLA COUNTY: Culebra Cañon, 9100 ft. (Warren, 1913a:11).

Sorex merriami

Merriam's Shrew

Sorex merriami is known from too few localities to assess adequately its status or distribution in Colorado. Available records are scattered widely in drier parts of the state on both sides of the Continental Divide, particularly in grasslands, open woodland, and areas where sagebrush is the predominant vegetation. The first records of *S. merriami* in Colorado were published in 1956, when specimens were reported from Larimer County (Hoffmeister, 1956), Moffat County (Starrett and Starrett, 1956), and Montezuma County (Rodeck and Anderson, 1956). Subsequent records have generally fallen within these extremes.

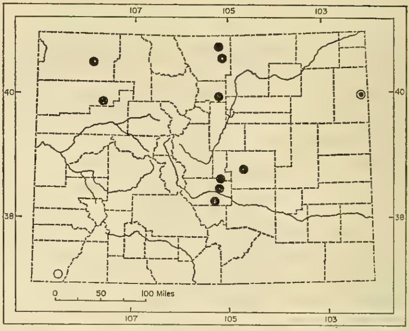


Fig. 14. Distribution of two species of shrews in Colorado. Single symbols, *Sorex merriami leucogenys*; concentric symbols, *Blarina brevicauda carolinensis.*

The natural history of Merriam's shrew in Colorado is mostly unknown. Altitudinal range of specimens examined from Phantom Canyon in Teller County was 6365 to 9685 feet. Phantom Canyon is on the south slope of the Pikes Peak massif. L. N. Brown (1967b) presented ecological data on *S. merriami* in the Laramie Basin, southern Wyoming. Armstrong and Jones (1971a) reviewed the literature on the distribution and natural history of the species.

Sorex merriami leucogenys Osgood

Sorex leucogenys Osgood, Proc. Biol. Soc. Washington, 22:52, 17 April 1909; type locality, mouth of canyon of Beaver River, about 3 mi. E Beaver, Beaver Co., Utah.

Sorex merriami leucogenys, Benson and Bond, Jour. Mamm., 20:348, 14 August 1939.

Distribution in Colorado.—The few records widely scattered in drier areas on both sides of the Continental Divide (Fig. 14).

Measurements.—External and cranial measurements are presented in table 1.

Remarks.—The two named subspecies of *Sorex merriami* are in need of critical review on the basis of the more abundant material now becoming available from many parts of the range of the species. Specimens from

Colorado are herein referred provisionally to *S. m. leucogenys* on the basis of external and cranial dimensions.

Records of occurrence.—Specimens examined, 48, distributed as follows: MOFFAT COUNTY: 4/10 mi. S U.S. Highway 40 on road to Juniper Springs, 1 (UMMZ). LARIMER COUNTY: Owl Canyon, 1 (UI); Soldier Canyon Dam, 1 mi. S Bellvue, 1 (FLC); below Dixon Dam, 4 mi. W Fort Collins, 1 (CSU). RIO BLANCO COUNTY: Dry Fork, White River, 6200 ft., 1 (AMNH). BOULDER COUNTY: Gregory Canyon, 1 (CU). TELLER COUNTY: Eightmile Creek, 9685 ft., 2 (KU); *Eightmile Creek, 9455 ft.,* 5 (KU); *Eightmile Creek, 9400 ft.,* 1 (KU); *Eightmile Creek, 9195 ft.,* 1 (KU); *Eightmile Creek, 8930 ft.,* 1 (KU). EL PASO COUNTY: Black Forest, 5 (KU). FREMONT COUNTY: *Eightmile Creek, 8470 ft.,* 1 (KU); *Eightmile Creek, 8225 ft.,* 1 (KU); *Eightmile Creek, 8140 ft.,* 1 (KU); *Eightmile Creek, 7990 ft.,* 2 (KU); *Eightmile Creek, 7840 ft.,* 1 (KU); *Eightmile Creek, 7475 ft.,* 1 (KU); *Eightmile Creek, 7440 ft.,* 1 (KU); *Eightmile Creek, 6960 ft.,* 1 (KU); Eightmile Creek, 6365 ft., 1 (KU); *26 1/10 mi. (by road) NE Silver Cliff, 5960 ft.,* 1 (KU); 19 mi. (by road) NE Silver Cliff, 7400 ft., 2 (KU); *17 4/10 mi. (by road) NE Silver Cliff, 7500 ft.,* 2 (KU); *17 mi. (by road) NE Silver Cliff, 7590 ft.,* 3 (KU). CUSTER COUNTY: *12 4/10 mi. (by road) NE Silver Cliff, 8000 ft.,* 2 (KU); *12 mi. (by road) NE Silver Cliff, 8100 ft.,* 1 (KU); *11 2/10 mi. (by road) NE Silver Cliff, 8200 ft.,* 5 (KU); *9 6/10 mi. (by road) NE Silver Cliff, 7989 ft.,* 1 (KU); *4 4/10 mi. (by road) NE Silver Cliff, 7950 ft.,* 1 (KU); *2 8/10 mi. (by road) NE Silver Cliff, 8013 ft.,* 2 (KU); 2 4/10 mi. (by road) NE Silver Cliff, 7970 ft., 1 (KU).

Additional records: MONTEZUMA COUNTY: head of Navajo Canyon, Mesa Verde National Park (Rodeck and Anderson, 1956:436); Mug House, Wetherill Mesa, Mesa Verde National Park (Hoffmeister, 1967:462).

Microsorex hoyi

PYGMY SHREW

Pettus and Lechleitner (1963) reported the first Colorado-taken specimens of *Microsorex hoyi.* These were captured in the upper Cache la Poudre drainage west of Fort Collins in pit-falls set out in conjunction with herpetological investigations. Spencer and Pettus (1966) reported on habitat preferences of pygmy shrews in the same area. *Microsorex hoyi* was taken most commonly in moist meadows, forest-meadow transitions, and coniferous forest. In the course of the above-mentioned study, 46 specimens were collected over the years 1961-1964. Vaughan (1969) reported *M. hoyi* from a subalpine park in an open stand of spruce and fir in northern Grand County. The limits of the range of the species in north-central Colorado are unknown.

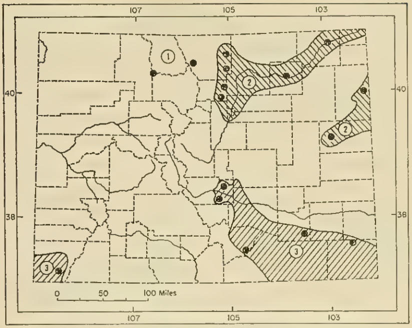


FIG. 15. Distribution of three species of shrews in Colorado. 1. *Microsorex hoyi montanus.* 2. *Cryptotis parva parva.* 3. *Notiosorex crawfordi crawfordi.* For explanation of symbols, see p. 9.

Apparently the population of *M. hoyi* in the Southern Rocky Mountains is isolated from other populations of the species by a considerable hiatus. Those records nearest to the Colorado-Wyoming population are in northwestern Montana and in northeastern South Dakota. As noted by Pettus and Lechleitner (1963) and L. N. Brown (1966), the wood frog *(Rana sylvatica)* has a similarly isolated population in the Medicine Bow Mountains.

Microsorex hoyi montanus Brown

Microsorex hoyi montanus Brown, Proc. Biol. Soc. Washington, 79:50, 23 May 1966; type locality, Trail's Divide Pond, ¼ mi. S University of Wyoming Science Summer Camp, Centennial, Albany Co., Wyoming.

Distribution in Colorado.—Known only from the mountains of Larimer and Grand counties (Fig. 15).

Measurements.—Average (and extreme) external measurements of three males and of five females, all from Larimer County (measurements of specimens preserved in fluid), are: 78.7 (76-82), 80.2 (75-83); 28.0 (26-29), 28.2 (27-29); 9.2 (9.0-9.5), 9.4 (9.0-10.0). Mean (and extreme) external and cranial measurements of 10 adults of both sexes from

Larimer County, Colorado, and Albany County, Wyoming (Brown, 1966:51) are: 82.5 (75-87), 28.0 (25-31), 9.3 (9.0-10.5); condylobasal length, 13.4 (13.2-13.6); cranial breadth, 6.1 (6.0-6.2); interorbital constriction, 3.0 (3.0-3.1); maxillary breadth, 3.9 (3.9-4.0); length of maxillary toothrow, 4.6 (4.5-4.7).

Records of occurrence.—Specimens examined, 21, distributed as follows: LARIMER COUNTY: *sec. 18 T. 7 N, R. 75 W*, 1 (CSU); *41 mi. W Fort Collins*, 6 (CSU); *36 mi. W Fort Collins*, 1 (CSU); Lily Pond, 2 mi. S Chambers Lake, 13 (FLC).

Additional record: GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan 1969:53).

Blarina brevicauda

SHORT-TAILED SHREW

The short-tailed shrew is known from Colorado by only two specimens, both from Yuma County, as reported by Jones and Loomis (1954). The animals were captured along the North Fork of the Republican River, approximately one and one-half miles west of the Nebraska border. It is of some interest that this species never has been captured at Wray, but a few miles to the west, although that area is better known than any other in northeastern Colorado, having been collected extensively by the Bureau of Biological Surveys and by local collectors for the Denver Museum of Natural History. In June 1968, an unsuccessful attempt was made to secure additional specimens of *Blarina brevicauda* at the precise locality reported by Jones and Loomis (1954). It seems to me possible that the species is rare in the Republican drainage of Colorado, or perhaps of only occasional occurrence, dispersing westward along the river and its tributaries from permanent, albeit localized, populations in adjacent Nebraska.

Jones and Findley (1954) discussed distribution and geographic variation in *B. brevicauda* on the Great Plains.

Blarina brevicauda carolinensis (Bachman)

Sorex carolinensis Bachman, Jour. Acad. Nat. Sci. Philadelphia, 7 (2):366, 1837; type locality, eastern South Carolina.

Blarina brevicauda carolinensis, Merriam, N. Amer. Fauna, 10:13, 31 December 1895.

Distribution in Colorado.—Known only from eastern Yuma County (Fig. 14).

Measurements.—External and cranial measurements of a male and a female, both young adults from Yuma County, are, respectively: 102, 104; 21, 24; 14, 15; condylobasal length, 21.0, 20.1; cranial breadth, 11.3, 11.0; maxillary breadth, 7.6, 7.5; interorbital constriction, 5.4, 5.4; length of maxillary toothrow, 8.5, 8.0.

Records of occurrence.—Specimens examined, 2, as follows: YUMA COUNTY: 1 mi. E Laird, 2 (KU).

Cryptotis parva

LEAST SHREW

The least shrew was first reported from Colorado by F. W. Miller (1924b) on the basis of specimens collected on Dry Willow Creek, south of Wray, Yuma County. For a description of this interesting and important locality, see Lincoln (1915). Jones and Loomis (1954) captured specimens of *Cryptotis parva* near Laird, Yuma County, and Beidleman and Remington (1955) reported the species from east of Crook, Logan County. In recent years, least shrews have been captured with increasing frequency in the vicinity of reservoirs adjacent to the mountain front, from near Wellington on the north southward to the vicinity of Boulder (see Lechleitner, 1964).

Inasmuch as the mammalian fauna of the Fort Collins-Boulder area has been sampled extensively and more or less continually since the 1920's, it seems to me possible that *C. parva* has only recently become established at its present western extremity, migration along the South Platte River and ecesis near the mountain front being made possible by the favorable and relatively stable habitat created by extensive irrigation.

Cryptotis parva parva (Say)

Sorex parvus Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains. . . , 1:163, 1823; type locality, Engineer Cantonment [approximately 2 mi. E Fort Calhoun, Washington Co.], Nebraska.

Cryptotis parva, G. S. Miller, Jr., Bull. U.S. Nat. Mus., 79:24, 31 December 1912.

Distribution in Colorado.—Drainages of South Platte and Republican rivers, northeastern part of state (Fig. 15).

Measurements.—External and cranial

measurements of a male and a female, both young adults from Yuma County, are, respectively: 81, 85; 18, 18; 11, 11; weights, 5.2, 4.7; condylobasal length, 15.5, 15.2; cranial breadth, 7.7, 7.9; maxillary breadth, 5.1, 4.7; interorbital constriction, 3.8, 3.5; length of maxillary toothrow, 5.4, 4.8.

Remarks.—Pokropus and Banta (1966) reported observations on a captive shrew from Phantom Canyon, 6095 ft., in Fremont County, under the name *C. parva.* These observations apply, in fact, to *Notiosorex crawfordi.* Likewise, specimens reported as *C. parva* from the Wet Mountains by Pokropus and Banta (1965:78) represent *N. crawfordi.* The least shrew is, therefore, unknown from the Arkansas Valley in Colorado, although its occurrence along the eastern boundary of the state is not unexpected.

Records of occurrence.—Specimens examined, 20, distributed as follows: LARIMER COUNTY: 2 mi. NE Wellington, 1 (CSU); *2 mi. E Wellington, 5200 ft.,* 1 (CSU); *Fossil Creek, 5 mi. S, 3/4 mi. W Fort Collins,* 2 (CSU); 6 mi. S, 3 mi. E Fort Collins, 2 (CSU); *Fossil Creek, SW 1/4 sec. 17, T. 6 N, R. 68 W, 6900 ft.,* 3 (CSU); *9 mi. S, 2 1/2 mi. E Fort Collins, 4700 ft.,* 2 (CSU). MORGAN COUNTY: Muir Springs, 2 1/2 mi. N, 2 1/2 mi. W Fort Morgan, 2 (KU). LOGAN COUNTY: 4 1/2 mi. W Crook, 1 (CU). BOULDER COUNTY: between Niwot and Longmont, 1 (CU); *Boulder Reservoir,* 1 (CU); 3 mi. S Boulder, 1 (CU). YUMA COUNTY: 1 mi. E Laird, 2 (KU). KIT CARSON COUNTY: 4 mi. E Flagler, 1 (KU).

Additional record: YUMA COUNTY: Boyes' Ranch, Dry Willow Creek, SW of Wray (F. W. Miller, 1924b:119).

Notiosorex crawfordi

Desert Shrew

The first specimen of *Notiosorex crawfordi* known from Colorado was reported by Finley (1954); this was a partial skull removed from an owl pellet obtained in Otero County. F. W. Miller (1924b) noted that the desert shrew had ". . . very provisionally been reported from the extreme southeastern section of the state." I know of no published report to which this statement might allude. Douglas (1967) reported a specimen captured at the Museum, Mesa Verde National Park.

Data are insufficient to indicate the status of *N. crawfordi* in southern Colorado. Specimens examined all are from semiarid shrublands, woodland, or grasslands, habitat typical of the species elsewhere in its range. Such habitat is widespread in southeastern and southwestern Colorado, and the desert shrew may eventually be found to occur over most of this area. Transect surveys by personnel of Colorado College obtained specimens at elevations from 5300 to 6800 feet in a section across the Arkansas Valley. The series obtained from Fremont County is one of the most extensive available from anywhere in the range of the desert shrew. For a review of the literature on *N. crawfordi,* see Armstrong and Jones (in press).

Notiosorex crawfordi crawfordi (Coues)

Sorex (Notiosorex) crawfordi Coues, Bull. U.S. Geol. and Geogr. Surv. Territories, 3:651, 15 May 1877; type locality, near Old Fort Bliss, about 2 mi. above El Paso, El Paso Co., Texas.

Notiosorex crawfordi, Merriam, N. Amer. Fauna, 10:32, 31 December 1895.

Distribution in Colorado.—At moderate elevations in southeastern and southwestern parts of state (Fig. 15).

Measurements.—External measurements of a subadult female from Montezuma County are: 68, 24, 10, 7. Representative cranial measurements of an adult of unknown sex from Huerfano County are: condylobasal length, 14.9; greatest length of skull, 15.8; cranial breadth, 7.2; interorbital constriction, 3.6; maxillary breadth, 4.5; length of maxillary toothrow, 5.7.

Remarks.—Behavorial observations reported by Pokropus and Banta (1966) under the name *Cryptotis parva* apply, in fact, to *N. crawfordi.* Close examination of the photograph of the animal in question (*op. cit.*:79) reveals the pronounced ears and relatively long, stout tail that are typical of the desert shrew. Based on material from western México, Armstrong and Jones (1971b) considered *N. crawfordi* to be polytypic.

Records of occurrence.—Specimens examined, 30, distributed as follows: FREMONT COUNTY: Eightmile Creek, 6780 ft., 1 (KU); *Eightmile Creek, 6600 ft.,* 2 (KU); *Eightmile Creek, 6440 ft.,* 1 (KU); *Eightmile Creek, 6365 ft.,* 3 (KU); *Eightmile Creek, 6170 ft.,* 3 (KU); *Eightmile Creek, 6095 ft.,* 4 (KU); *Eightmile Creek, 6070 ft.,* 1 (KU); *Eightmile Creek, 5730 ft.,* 1 (KU); *Eightmile Creek, 5625 ft.,* 1 (KU); *Eightmile Creek, 5300 ft.,* 1 (KU); *26 1/2 mi. (by road) NE Silver Cliff, 5900 ft.,* 2 (KU); *24 1/2 mi.*

(by road) NE Silver Cliff, 6200 ft., 3 (KU); *22 6/10 mi. (by road) NE Silver Cliff, 6490 ft.,* 1 (KU); 22 3/10 mi. (by road) NE Silver Cliff, 6600 ft., 1 (KU); *20 6/10 mi. (by road) NE Silver Cliff, 6800 ft.,* 1 (KU). OTERO COUNTY: 3 mi. NW Higbee, 4300 ft., 1 (KU). HUERFANO COUNTY: 9 9/10 mi. NNW Aguilar, 1 (MVZ). MONTEZUMA COUNTY: Museum, Mesa Verde National Park, 1 (KU). BACA COUNTY: 14 mi. N, 4 mi. E Springfield, 1 (KU).

Family Talpidae—Moles

Scalopus aquaticus

Eastern Mole

The eastern mole occurs in northeastern Colorado in friable soils of valleys of major rivers. Recently the species has been discovered to occur along the Cimarron River in the extreme southeastern part of the state (Vaughan, 1961a). Moles in eastern Colorado are closely restricted to sandhills and floodplains where soil moisture is relatively high and stable. To my knowledge, no study has been made of the economic importance of *Scalopus aquaticus* in Colorado, and little is known of the biology of the species at the western margin of its range.

Scalopus aquaticus caryi Jackson

Scalopus aquaticus caryi Jackson, Proc. Biol. Soc. Washington, 27:20, 2 February 1914; type locality, Neligh, Antelope Co., Nebraska.

Distribution in Colorado.—Valleys of South Platte, Republican and Arikaree rivers, northeastern part of state (Fig. 16).

Comparison.—From *S. a. intermedius*, the subspecies of southeastern Colorado, *S. a. caryi* differs in paler (more silvery, less brownish) color of upper parts, less ochraceous snout and wrists, and generally smaller size both externally and cranially.

Measurements.—Average (and extreme) external measurementes of four males, followed by those of four females, all from Yuma County, are: 161.5 (145-171), 146.7 (140-155); 29.5 (25-32), 24.6 (20-29); 20.4 (20-21), 19.5 (18-22). Mean (and extreme) cranial measurements of five males and three females from Yuma County are: greatest length of skull, 34.00 (32.4-34.9), 32.80 (31.7-34.3); condylobasal length, 33.00 (31.5-34.2), 31.93 (30.9-33.4); mastoid breadth, 17.35 (16.8-17.8), 16.93 (16.1-17.7); postorbital constriction, 7.75 (7.6-7.9), 7.63 (7.3-7.9); length of maxillary toothrow, 13.08 (12.5-13.8), 12.70 (12.1-13.0).

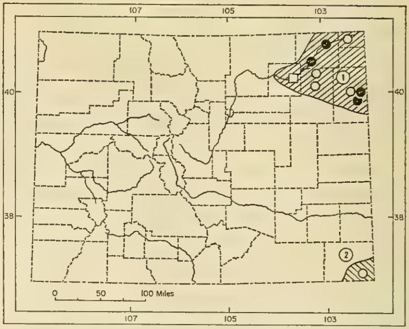


Fig. 16. Distribution of *Scalopus aquaticus* in Colorado. 1. *S. a. caryi*. 2. *S. a. intermedius*. For explanation of symbols, see p. 9.

Remarks.—*Scalopus aquaticus* reaches the western limits of its range in eastern Colorado and southeastern Wyoming; specimens from this area are, on the average, smaller and paler in color than those from anywhere else in the range of the species. Jones (1964:75) noted that the pale color of *S. a. caryi* generally is consistent throughout the range of the subspecies in Nebraska, but that specimens from the western part of the state are smaller in size than those from the vicinity of the type locality in Antelope County. Coloradan specimens agree in cranial dimensions with specimens reported by Jones (*op. cit.*:77) from Dundy County, Nebraska. Maximum external measurements of Coloradan specimens reported herein are misleadingly large; the values were converted to millimeters from original data recorded in inches and hundredths of inches.

Records of occurrence.—Specimens examined, 15, distributed as follows: LOGAN COUNTY: sec. 34, T. 9 N, R. 50 W, 1 (CSU); Merino, 2 (CSU). WASHINGTON COUNTY: Eastern Colorado Range Experiment Station, 14 mi. N Akron, 1 (UU). YUMA COUNTY: Dry Willow, 4 (DMNH); Wray, 7 (6 DMNH, 1 USNM).

Additional records: MORGAN COUNTY: no precise locality (Lechleitner, 1969:35). SEDGWICK COUNTY: near Julesburg (Burnett, 1924a:264).

WASHINGTON COUNTY: 15 mi. N Akron (Vaughan, 1961:171); near Akron (Burnett, 1924a: 264). YUMA COUNTY (Cary, 1911:201): *5 mi. W Wray; Chief Creek, Wray; 1 mi. E Wray;* 12 mi. W Wray.

Scalopus aquaticus intermedius (Elliot)

Scalops machrinus intermedius Elliot, Field Columbian Mus., Publ. 37 (Zool. Ser., 1):280, 15 May 1899; type locality, Alva, Woods Co., Oklahoma.

Scalopus aquaticus intermedius, V. Bailey, N. Amer. Fauna, 25:207, 24 October 1905.

Distribution in Colorado.—Known only from extreme southeastern Baca County (Fig. 16).

Comparison.—For comparison with *S. a. caryi,* see account of that subspecies.

Measurements.—A sample of specimens of this subspecies is not available from Colorado. Mean (and extreme) external measurements of eight males from Meade County, Kansas, are: 160.9 (149-168), 30.1 (24-34), 22.0 (20-24). Average (and extreme) cranial measurements of nine males from the same area are: greatest length of skull, 35.20 (33.9-36.3); condylobasal length, 34.50 (33.3-35.6); mastoid breadth, 18.28 (17.9-18.7); postorbital constriction, 7.89 (7.6-8.2); length of maxillary toothrow, 12.40 (12.0-13.0).

Remarks.—The only available record of *Scalopus aquaticus* in southeastern Colorado is that published by Vaughan (1961a:171). Reference to *S. a. intermedius* is on geographic grounds. Moles are unknown on interfluvial uplands along the eastern boundary of Colorado, and in the Arkansas River Valley. In Kansas, they are known to range westward in the Arkansas watershed only to Stafford County (Cockrum, 1952:53) although they occur in the Cimarron drainage in the extreme southwestern part of that state.

Records of occurrence.—Specimens examined, none.

Additional record: BACA COUNTY: near Cimarron River, 16 mi. S Stonington (Vaughan, 1961a: 171).

Order CHIROPTERA

Colorado is within the known range of 16 species of bats, representing two families and eight genera. At least three other species range near the boundaries of Colorado and are of possible or probable occurrence.

It is difficult to reconstruct the probable range of several chiropteran species prior to the advent of European civilization in Colorado. Today a number of kinds roost in mines, tunnels, and buildings. It is not known whether the utilization of such cover represents a change in habitat preference by populations long indigenous to the state, or whether the populations are recent additions to the fauna. In the typical case, probably both situations obtain, populations having been quick to adapt to environmental novelties, thereby allowing some expansion within a range already held by the species. On the other hand, the presence of buildings on the plains where once there had been no suitable habitat certainly has allowed some local extensions of ranges.

Many species of bats make seasonal migrations, although detailed migratory patterns of most species remain to be learned. Of Coloradan bats, only three species *(Myotis leibii, Eptesicus fuscus, Plecotus townsendii)* are definitely known to hibernate in the state, although probably several other species of *Myotis, Pipistrellus hesperus* and *Antrozous pallidus* overwinter there also. There are sexual differences in migratory patterns, so that males of *Lasionycteris noctivagans* and *Lasiurus cinereus* occur in Colorado commonly as summer residents, but females do not.

Because of the tendency of some kinds of bats to congregate in appreciable numbers in roosts accessible to man, populations are particularly susceptible to wanton destruction. All bats in Colorado are insectivorous. They doubtless are a resource of considerable economic importance, although this value has not been quantified. Furthermore, bats are of increasing scientific interest. The bats of Colorado should be given explicit legal protection.

The recent book by Barbour and Davis (1969) provided information on the biology of several species of bats in Colorado, and also included photographs in color of all species that occur in the state.

As noted in the statement on methods, five external measurements are included in the following accounts of bats, the fifth being length of forearm; this measurement was taken by me, usually from dried skins, by means of dial calipers.

Key to Species of Chiroptera in Colorado

1. Tail extending little or not at all beyond posterior border of uropatagium; fibula slender or rudimentary 2
   Distal third of tail extending beyond posterior border of uropatagium; fibula robust, nearly half the diameter of tibia 18
2. Upper incisors 2/2 3
   Upper incisors 1/1 16
3. Cheekteeth 6/6, total teeth 38 4
   Cheekteeth fewer than 6/6, total teeth 36 or fewer 11
4. Underside of wing well-furred to elbow; rostrum markedly shortened, braincase distinctly elevated from rostrum .... *Myotis volans*
   Underside of wing not furred to elbow; rostrum not markedly shortened, braincase usually not rising abruptly from rostrum 5
5. Foot small, 40 to 45 per cent of length of tibia 6
   Foot medium to large, 48 to 60 per cent of length of tibia 7
6. Hairs of dorsum having burnished tips; third metacarpal shorter than forearm; braincase flattened and profile rising gradually .... *Myotis leibii*
   Hairs of dorsum lacking burnished tips; third metacarpal longer than forearm; braincase rounded and profile rising abruptly .... *Myotis californicus*
7. Condylobasal length greater than 16, cheekteeth robust; forearm usually 44 or greater .... **Myotis velifer*
   Condylobasal length less than 16, cheekteeth not markedly robust; forearm usually less than 43 8
8. Posterior border of uropatagium having conspicuous fringe of stiff hairs; forearm 41 or greater .... *Myotis thysanodes*
   Posterior border of uropatagium lacking conspicuous fringe of hairs; forearm usually less than 41 9
9. Ear long, 21 to 24, extending past end of nose when laid forward .... *Myotis evotis*
   Ear shorter, less than 18, not extending past end of nose when laid forward 10
10. Hairs of dorsum having burnished tips; forearm 35 to 40; greatest length of skull 14.3 to 15.3 .... *Myotis lucifugus*
    Hairs of dorsum lacking burnished tips; forearm 32 to 37; greatest length of skull 13.2 to 14.2 .... *Myotis yumanensis*
11. Ears relatively short, rounded; hairs of dorsum short, tipped with white .... *Lasionycteris noctivagans*
    Ears more or less pointed, hairs of dorsum lacking white tips 12
12. Length of ear less than 25 13
    Length of ear greater than 25 14
13. Total teeth 34; forearm less than 32 .... *Pipistrellus hesperus*
    Total teeth 32; forearm greater than 44 .... *Eptesicus fuscus*
14. Cheekteeth 5/5, total teeth 34; dorsal color black, marked with three large white spots .... **Euderma maculatum*
    Cheekteeth 5/6, total teeth 36; dorsal color brownish, without white patches 15
15. Breadth of braincase usually less than one-half the greatest length of skull; calcar not keeled .... *Plecotus townsendii*
    Breadth of braincase slightly more than one-half the greatest length of skull; calcar keeled .... **Plecotus phyllotis*
16. Incisors 1/2, total teeth 28; dorsal surface of uropatagium not densely furred to posterior border .... *Antrozous pallidus*
    Incisors 1/3, total teeth 32; dorsal surface of uropatagium densely furred to posterior border 17
17. Greatest length of skull less than 14; hairs of dorsum brick red to rusty red; forearm 37 to 43 .... *Lasiurus borealis*
    Greatest length of skull greater than 17; dorsal hairs brown, heavily washed with white; forearm 46 to 55 .... *Lasiurus cinereus*

18. Breadth of rostrum markedly greater than interorbital breadth; ears not united at base and extending little beyond muzzle when laid forward; forearm less than 45 .... *Tadarida brasiliensis*

Breadth of rostrum only slightly greater than interorbital breadth; ears united at base and extending well beyond muzzle when laid forward; forearm greater than 55 .... *Tadarida macrotis*

Family VESPERTILIONIDAE—Common Bats

Myotis lucifugus

LITTLE BROWN BAT

Myotis lucifugus ranges across most of temperate North America and is most characteristic of forested areas. Records in Colorado are primarily from the mountains, at elevations to 11,000 feet in Lake County, but the species also occurs locally at the western edge of the plains, roosting in buildings. The species presently is unrecorded from the eastern third of the state. At higher elevations, clusters of individuals roost in mines, tunnels, caves, or even hollow trees. *Myotis lucifugus* is migratory, but movements in Colorado have not been documented, and the winter range of Coloradan animals is unknown.

Individuals of *M. lucifugus* exhibit a wide range in color of pelage. Pale specimens may be superficially similar to *Myotis yumanensis*, from which species *M. lucifugus* differs as follows: more marked burnished tips of hairs of dorsum; more flattened skull, with the profile of the forehead less steep; broader, more inflated interorbital region; alveolar line ascending more gradually anteriorly; rostrum longer; braincase relatively broader (after Harris and Findley, 1962, which see for more detailed comparisons and illustrations).

Myotis lucifugus carissima Thomas

Myotis (Leuconoë) carissima Thomas, Ann. Mag. Nat. Hist., ser. 7, 13:383, May 1904; type locality, Lake Hotel, Yellowstone National Park, Wyoming.

Myotis lucifugus carissima, Cary, N. Amer. Fauna, 42:43, 3 October 1917.

Distribution in Colorado. — At moderate elevations in and near mountains of western two-thirds of state (Fig. 17).

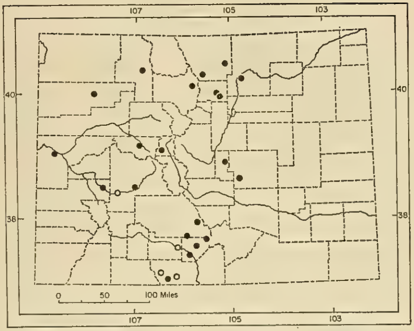


FIG. 17. Distribution of *Myotis lucifugus carissima* in Colorado. For explanation of symbols, see p. 9.

Comparison. — From *M. l. occultus*, the subspecies geographically adjacent to the south in New Mexico, *M. l. carissima* differs in smaller cranial size, smaller teeth, in typically having two small upper premolars on each side (rather than one), and in pale to dark brown rather than reddish brown color. For detailed comparisons, see Findley and Jones (1967) and Barbour and Davis (1970).

Measurements. — Average (and extreme) external measurements of 14 females from Lake County, 10 females from Alamosa County, and 17 females from Conejos County are, respectively: 94.9 (89-102), 96.7 (94-100), 98.7 (93-100); 40.5 (37-44), 41.0 (37-45), 41.0 (36-45); 10.6 (10-11), 10.7 (10-11), 10.8 (10-12); 14.7 (14-16), 15.4 (15-16), 15.1 (14-16); 38.13 (36.9-40.3), 39.71 (38.4-41.9), 39.06 (37.6-40.5).

For cranial measurements, see table 3. Additional measurements and statistical analyses are presented by Findley and Jones (1967).

Remarks.—Specimens of a large, pale kind of *Myotis* from northwestern Colorado were named as *M. lucifugus phasma* by Miller and Allen (1928:53). Following the suggestion of Harris and Findley (1962), this population is herein considered to represent *M. yumanensis*. For additional remarks, see the account of the latter species.

Findley and Jones (1967) studied the re-

TABLE 3

Selected cranial measurements of seven species of *Myotis*.

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Mastoid breadth	Interorbital constriction	Length of maxillary toothrow	Length of mandibular toothrow
Myotis lucifugus carissima, Twin Lakes, Lake County							
Mean, 14 ♀	14.53	13.69	9.04	7.67	3.89	5.51	6.59
Minimum	13.8	13.2	8.5	7.4	3.6	5.3	6.4
Maximum	15.2	14.5	9.5	8.0	4.2	5.7	6.8
vicinity of Mosca, Alamosa County							
Mean, 10 ♀	15.18	14.67	9.97	8.49	4.55	5.93	7.12
Minimum	14.7	14.4	9.8	8.2	4.3	5.7	6.9
Maximum	15.6	15.1	10.3	8.6	4.7	6.2	7.4
Conejos, Conejos County							
Mean, 10 ♀	14.92	14.23	9.29	7.81	4.00	5.61	6.98
Minimum	14.7	14.0	9.0	7.6	3.9	5.5	6.8
Maximum	15.1	14.6	9.5	8.0	4.4	5.7	7.2
Myotis yumanensis yumanensis, Echo Park, Moffat County							
KU 116718, ♂	14.6	13.5	8.7	7.5	3.9	5.6	7.1
Conejos, Conejos County							
UK 4782, ♀	14.6	13.6	9.0	7.8	4.4	5.6	6.8
Allison, La Plata County							
UNM 10043, ♀	14.6	13.9	8.0	7.5	3.9	5.5	6.7
Myotis evotis evotis, 1 mi. SW Cross Mountain, Moffat County							
KU 57678, ♂	15.7	15.0	9.2	7.9	3.8	5.9	7.0
KU 57679, ♂	15.5	14.8	—	7.6	3.7	6.0	7.0
KU 57680, ♂	15.5	14.7	9.4	7.7	3.8	6.0	7.0
Black Canyon of the Gunnison National Monument, Montrose County							
CU (uncat.), ♂	15.6	14.8	—	—	3.8	6.0	7.4
CU (uncat.), ♀	15.2	14.3	9.0	7.4	3.7	5.9	7.0
Myotis thysanodes thysanodes, Mesa Verde National Park, Montezuma County							
KU 69250, ♀	15.5	14.9	9.9	8.1	3.9	6.0	7.2
Myotis volans interior, 2 1/2 mi. S Estabrook, Park County							
Mean, 6 ♂	14.48	13.93	8.72	7.72	3.95	5.40	—
Minimum	14.3	13.8	8.3	7.5	3.8	5.3	—
Maximum	14.7	14.2	9.1	7.9	4.1	5.5	—
Mean, 9 ♀	14.73	14.24	8.82	7.93	4.00	5.41	—
Minimum	14.6	14.1	8.4	7.8	3.9	5.3	—
Maximum	15.0	14.4	9.1	8.1	4.1	5.5	—
Myotis californicus stephensi, Bedrock, Montrose County							
WC 3016, ♂	13.0	12.1	—	6.7	2.9	4.7	6.0
Myotis leibii ciliolabrum, 27 mi. NNW Fort Collins, Larimer County							
KU 70015, ♀	14.4	13.6	8.6	7.2	3.2	5.2	6.5
Myotis leibii melanorhinus, Mesa Verde National Park, Montezuma County							
Mean, 4 ♂	13.97	12.90	8.30	6.82	3.20	5.35	6.48
Minimum	13.5	12.4	8.0	6.7	3.1	5.2	6.2
Maximum	14.2	13.3	8.5	7.0	3.4	5.4	6.7
KU 69247, ♀	14.1	13.2	8.2	6.8	3.2	5.6	6.4

lationship between populations of *M. lucifugus* and *M. occultus* in the Southern Rocky Mountains, tentatively concluding that the two nominal species are only subspecifically distinct. Two specimens from the San Luis Valley in Colorado were considered to be intergrades between the two populations, as were specimens from western Colfax County, New Mexico. The intergrades were judged to be closer to a sample from Las Vegas, New Mexico, than to a sample from Fort Collins, Colorado. One infers that the sample from Las Vegas was considered to represent *occultus,* although the locality does not appear in the list of specimens examined by those authors (*op. cit.*:442-443).

Barbour and Davis (1970:150) agreed with Findley and Jones (1967) that *occultus* is best arranged as a subspecies of *M. lucifugus.* On the basis of greatly improved samples from the San Luis Valley, all Coloradan specimens were judged to be referable to *M. l. carissima.* I have examined some of the material collected by Barbour and Davis and agree that animals from Colorado are best referred to *carissima.* Although intermediate in size between the two subspecies, few specimens approach the rich reddish color of *occultus.* The modal number of small upper premolars in individuals from the San Luis Valley is four, as is typical of *carissima.*

Records of occurrence.—Specimens examined, 176, distributed as follows: ROUTT COUNTY: Steamboat Springs, 2 (1 CU, 1 USNM). LARIMER COUNTY: Fort Collins, 45 (1 CSC, 44 UNM); 4 1/2 mi. SW Estes Park, 1 (KU). WELD COUNTY: 1 mi. S La Salle, 1 (CSC). RIO BLANCO COUNTY: Meeker, 2 (USNM). GRAND COUNTY: Arapahoe Valley Lodge, Shadow Mountain National Recreation Area, 1 (RMNP). BOULDER COUNTY: 1/2 mi. SE Jamestown, 1 (CU); Boulder, 2 (1 CSC, 1 CU). MESA COUNTY: Headquarters, Colorado National Monument, 1 (CU); *Colorado National Monument,* 1 (CNM). PITKIN COUNTY: Aspen, 2 (DMNH). LAKE COUNTY: 9 mi. SW Leadville, 11,000 ft., 2 (KU); Twin Lakes, 9200 ft., 17 (UK). GUNNISON COUNTY: Gunnison, 1 (UMMZ). TELLER COUNTY: Woodland Park, 1 (AMNH). EL PASO COUNTY: Fort Carson, 1 (FMNH). MONTROSE COUNTY: *Jones Summit, Black Canyon of the Gunnison National Monument,* 3 (CU); Grizzly Gulch, 2 (CU); *Black Canyon of the Gunnison National Monument,* 2 (1 CU, 1 CNM). SAGUACHE COUNTY: 1 1/2 mi. N Crestone, 8050 ft., 4 (KU); 9 mi. E Center, 18 (AMNH); *no locality other than county,* 1 (AMNH). ALAMOSA COUNTY: Mosca Creek, 8800 ft., 1 (GSDNM); *S of Great Sand Dunes National Monument,* 1 (GSDNM); *1 mi. N, 3 mi. E Mosca,* 12 (UK); *1 mi. N, 4 mi. E Mosca,* 18 (UK); 4 mi. E Mosca, 2 (1 CU, 1 USNM); Alamosa, 2 (ASC). CONEJOS COUNTY: Conejos River, 8300 ft., 1 (USNM); courthouse, Conejos, 7900 ft., 29 (UK).

Additional records (Barbour and Davis, 1970:150, unless otherwise noted): GUNNISON COUNTY: Dry Gulch at Gunnison River (Durrant and Robinson, 1962:239). RIO GRANDE COUNTY: Home Lake, 7066 ft. CONEJOS COUNTY: Spectacle Lake, 8800 ft.; *La Manga Creek, 9000 ft.*

Myotis yumanensis

YUMA MYOTIS

Myotis yumanensis occurs in semiarid to arid situations over much of western North America. Coloradan records are typically from lower elevations in or near canyonlands. The Yuma myotis roosts in caves or unoccupied buildings. The winter range of the Coloradan population is unknown. The northeastern extreme of the known range is in El Paso County, Colorado; *M. yumanensis* was first reported from eastern Colorado by Constantine (1966). For comparison with *Myotis lucifugus,* see the account of that species.

Myotis yumanensis yumanensis (H. Allen)

Vespertilio yumanensis H. Allen, Smithsonian Misc. Coll., 7 (Publ. 165):58, June 1864; type locality, Old Fort Yuma, Imperial Co., California.

Myotis yumanensis, G. S. Miller, Jr., N. Amer. Fauna, 13:66, 16 October 1897.

Myotis lucifugus phasma Miller and Allen, Bull. U.S. Nat. Mus., 144:53, 25 May 1928; type locality, [Little] Snake River, S of Sunny Peak, Moffat Co., Colorado (see remarks).

Distribution in Colorado. — Known from scattered localities in western and southeastern parts of state (Fig. 18).

Measurements.—External measurements of a male from western Moffat County, a female from Conejos County, and two females from La Plata County are, respectively: 85, 86, 86, 88; 37, 38, 39, 47; 11, 10, 10, 11; 16, 15, 16, 15; 37.9, 36.2, 37.9, 34.3. For cranial measurements, see table 3.

Remarks. — Cary (1911:207) reported a collection of three specimens of *M. yumanensis* from "western Routt County" (now Moffat County) — two females from "Snake River, south of Sunny Peak," and a male from Lily. Miller and Allen (1928:53) named *Myotis*

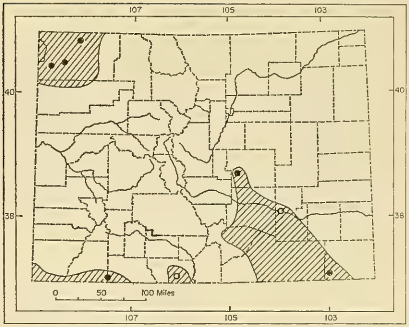


FIG. 18. Distribution of *Myotis yumanensis yumanensis* in Colorado. For explanation of symbols, see p. 9.

lucifugus phasma, designating as the holotype one of the above-mentioned specimens collected by Cary (USNM 148159), and referring to the new subspecies the other two Coloradan specimens supposed by Cary (*loc. cit.*) to represent *M. yumanensis,* as well as a specimen from Inyo County, California.

Hall and Kelson (1959:162) mapped the distribution of *M. l. phasma* in such a way that the type locality was excluded from the range of the subspecies. This situation perhaps stemmed from the usage of Durrant (1952:41) in Utah, who admitted as *phasma* a single record from Juab County, while applying the name *M. l. carissima* to all other specimens of supposed *lucifugus* from Utah.

Harris and Findley (1962) reviewed the status of *M. l. phasma.* Two specimens from Allison, La Plata Co., Colorado, were judged to be conspecific with a topotype and near topotype of *phasma.* Comparison of these specimens with specimens of *M. l. carissima* led to the conclusion that *phasma* is not a subspecies of *M. l. lucifugus.* According to Harris and Findley (1962:194), ". . . Colorado specimens to which the name *M. l. phasma* has been applied represent one extreme of a cline in size (and in characters which may be correlated with size) which extends from at least as far south as Ft. Yuma, Imperial Co., California, in a northerly and then easterly direction into western Colorado. . . . At present, in the absence of further evidence as to the nature of the cline, all of these animals may be known as *M. y. yumanensis.*"

Miller and Allen (1928:68) listed as from Colorado a specimen examined from "Colorado River, Horse Shoe Bend." Harris and Findley (1962) suspected that the specimen was, in fact, from California or Baja California. The only Horseshoe Bend in the Colorado drainage with which I am familiar is on the Green River, T. 6 S, R. 21 W, Uintah Co., Utah, some 12 mi. S of Vernal. That the mention of Colorado in this context was a *lapsus* on the part of Miller and Allen is indicated by the comment of those authors on the absence of specimens of *M. yumanensis* from Colorado (*op. cit.*:67).

Identification of the specimen listed from Skull Cañon, Baca County (a male, CU 5873), is tentative. The hairs of the dorsum are a dirty grayish buff and appear to have slightly burnished tips. The specimen was preserved in formalin-phenol-glycerin for seven days prior to preparation. The typical effect of this preservative is to dull the coat, evidently by removing oils. Apparent slight bleaching probably is a result of changes in the texture of the pelage with over-drying following removal of oils (see Sutton, 1962). External measurements of this specimen are 82, 33, 10, 10, 33.8.

Records of occurrence.—Specimens examined, 9, distributed as follows: MOFFAT COUNTY: [Little] Snake River, S of Sunny Peak, 2 (USNM); Lily, 1 (USNM); Echo Park, 10 mi. N Artesia [Dinosaur], 1 (KU). EL PASO COUNTY: Fort Carson, 1 (UNM). LA PLATA COUNTY: Allison, 2 (UNM). CONEJOS COUNTY: courthouse, Conejos, 7900 ft., 1 (UK). BACA COUNTY: Skull Cañon, 4600 ft., 1 (CU—see remarks).

Additional records: OTERO COUNTY: near mouth of Apishapa Creek (Glass and Baker, 1968: 259).

Myotis evotis

LONG-EARED MYOTIS

Myotis evotis is a bat of coniferous woodlands of middle elevations in Colorado, where it roosts primarily in trees, and of semiarid shrublands, where it has been known to occupy abandoned buildings. Most records from the state are from elevations above 6000 feet, the highest being Hallowell Park, about 8400

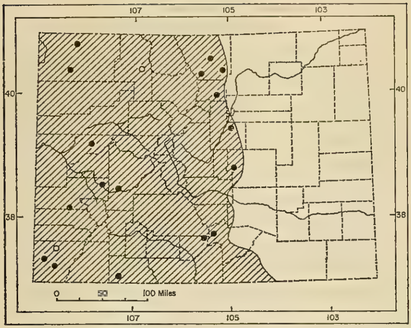


FIG. 19. Distribution of *Myotis evotis evotis* in Colorado. For explanation of symbols, see p. 9.

feet, in Rocky Mountain National Park. Little is known of the natural history of the long-eared myotis. Although known to migrate, the winter range is uncertain.

For comparison with the fringed myotis, *Myotis thysanodes*, see the account of that species.

Myotis evotis evotis (H. Allen)

Vespertilio evotis H. Allen, Smithsonian Misc. Coll., 7 (Publ. 165):48, June 1864; type locality, Monterey, Monterey Co., California.

Myotis evotis, G. S. Miller, Jr., N. Amer. Fauna, 13:77, 16 October 1897.

Distribution in Colorado.—Foothills, plateaus, and lower mountains on both sides of Continental Divide (Fig. 19).

Measurements.—External measurements of three males from western Moffat County and two males from Montezuma County are: 94, 89, 91, 90, 91; 46, 44, 42, 44, 43; 10, 8, 10, 10, 10; 23, 22, 23, 23, 23; 39.2, 37.8, 37.6, 39.0, 39.4; weights of two males from Montezuma County, 5.0, 6.4. External measurements of two females from eastern Montrose County are: 88, 90; 41, 41; 8, 10; 22, 21; 38.6, 38.1. Selected cranial measurements are presented in table 3.

Remarks.—H. Allen (1864) designated no type locality when he described *M. evotis*. G. S. Miller, Jr. (1897:78) fixed the type locality at Monterey, California. For a discussion of the nomenclatural history of this species, see Dalquest (1943).

Records of occurrence.—Specimens examined, 45, distributed as follows: MOFFAT COUNTY: [Little] Snake River, S of Sunny Peak, 5 (USNM); *[Little] Snake River*, 2 (1 MCZ, 1 USNM); 1 mi. SW Cross Mountain, 3 (KU). LARIMER COUNTY: 14 mi. W Fort Collins, 1 (CSU); Loveland, 1 (USNM); *Hallowell Park*, 1 (RMNP); Moraine Park, 5 (RMNP). BOULDER COUNTY: Boulder, 2 (CU). MESA COUNTY: 4 mi. S, 3 mi. E Collbran, 1 (KU). DOUGLAS COUNTY: Daniel's Park, 1 (DMNH). GUNNISON COUNTY: 4 mi. W Sapinero, 7750 ft., 1 (KU). EL PASO COUNTY: 3 mi. N Colorado Springs, 5 (AMNH); *Colorado Springs*, 1 (AMNH). MONTROSE COUNTY: *Jones Summit, Black Canyon of the Gunnison National Monument*, 1 (CU); *Grizzly Gulch*, 1 (CU); 1/2 mi. SE North Rim Headquarters, Black Canyon of the Gunnison National Monument, 1 (CU); *Black Canyon of the Gunnison National Monument*, 1 (CNM); Coventry, 2 (MCZ). ALAMOSA COUNTY: Mosca Creek, 8800 ft., 1 (GSDNM); *Mosca Creek Pond*, 1 (GSDNM). HUERFANO COUNTY: 12 1/2 mi. W Gardner, 6000 ft., 1 (CSU). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 1 (USNM); Rock Springs, Mesa Verde National Park, 7400 ft., 2 (KU); *Museum, Mesa Verde National Park, 6950 ft.*, 1 (KU). ARCHULETA COUNTY: Deep Cañon, 3 (UNM).

Additional records: ROUTT COUNTY: Yellowjacket Mountains, 21 km. E Steamboat Springs (Young, 1908:408). GUNNISON COUNTY (Durrant and Robinson, 1962:242): *Dry Gulch at Gunnison River, 7400 ft.; Red Creek at Gunnison River, 7460 ft.* MONTEZUMA COUNTY: Dolores (Miller and Allen, 1928:117); *Chickaree Draw, Prater Canyon, Mesa Verde National Park* (Anderson, 1961:38).

Myotis thysanodes

FRINGED MYOTIS

The status of the fringed myotis in Colorado is poorly known. An isolated subspecies, *Myotis thysanodes pahasapensis*, occurs on the Black Hills of South Dakota and Wyoming (Jones and Genoways, 1967), but otherwise, specimens from Colorado provide the northeasternmost records of the species. Perhaps further research will confirm the suspicion that *M. thysanodes* is not especially common at the edge of its range. Barbour and Davis (1969:87) provided data on habitat and reproduction of the fringed myotis in El Paso County. Throughout its range in the western United States, *M. thysanodes* seems to prefer coniferous woodlands and desert-scrub situations, where individuals roost in crevices, caves, mines, or buildings. The winter range of Coloradan animals is not known.

Myotis thysanodes is not infrequently con-

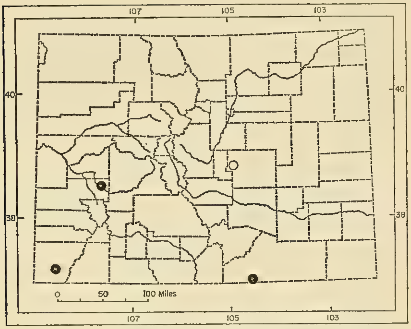


FIG. 20. Distribution of *Myotis thysanodes thysanodes* in Colorado. For explanation of symbols, see p. 9.

fused with *Myotis evotis*, from which the former species may be distinguished by its shorter ear (17 to 20, as opposed to 21 to 24), longer forearm, and conspicuously fringed uropatagium. Identification is generally not difficult if comparative material is available.

Myotis thysanodes thysanodes G. S. Miller, Jr.

Myotis thysanodes G. S. Miller, Jr., N. Amer. Fauna, 13:80, 16 October 1897; type locality, Old Fort Tejon, Tehachapi Mountains, Kern Co., California.

Distribution in Colorado.—Known from scattered localities at moderate elevations near the mountains on both sides of the Continental Divide (Fig. 20).

Measurements.—External measurements of females from Montezuma and Montrose counties are: 86, 81; 37, 37; 9, 11; 18, 21; 43.7, 39.4; weight of the individual from Montezuma County, 7.0. Representative cranial measurements are presented in table 3.

Records of occurrence.—Specimens examined, 3, distributed as follows: MONTROSE COUNTY: Grizzly Gulch, Black Canyon of the Gunnison National Monument, 1 (CU). MONTEZUMA COUNTY: Rock Springs, 7400 ft., Mesa Verde National Park, 1 (KU). LAS ANIMAS COUNTY: near Wooton, 7500 ft., 1 (UNM).

Additional record: EL PASO COUNTY: [6 mi. N, 1 mi. W] Colorado Springs (Barbour and Davis, 1969:87).

Myotis volans

LONG-LEGGED MYOTIS

The long-legged myotis is a bat of western North America, reaching the limits of its range in Colorado, Nebraska, and South Dakota. The bats roost in a wide variety of situations, including trees, buildings, and crevices in rocks. Caves are used as night-roosts. Large nursery colonies are formed throughout the summer range. Long-legged bats apparently migrate, but the extent and direction of these movements are unknown. Findley (1954b) reported on reproduction in *Myotis volans* in Boulder County. Farney and Fleharty (1969) presented data on wing-loading in this species, and a number of other Coloradan bats.

Myotis volans interior G. S. Miller, Jr.

Myotis longicrus interior G. S. Miller, Jr., Proc. Biol. Soc. Washington, 27:211, 31 October 1914; type locality, 5 mi. S Twining, 11,300 ft., Taos Co., New Mexico.

Myotis volans interior, Miller and Allen, Proc. U.S. Nat. Mus., 144:142, 25 May 1928.

Distribution in Colorado.—Wooded areas of western three-fifths of state (Fig. 21).

Measurements. — Average (and extreme) external measurements of six males and nine females from 2 1/2 mi. S Estabrook, Park County, are: 97.3 (96-99), 102.0 (99-106); 41.2 (40-43), 41.6 (38-46); 9.0 (9-9), 8.9 (8-9); 12.7 (12-13), 12.3 (11-14); 37.75 (36.9-39.1), 38.19 (37.2-38.8); weight, 8.72 (8.0-

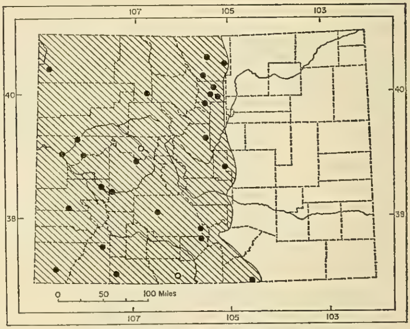


FIG. 21. Distribution of *Myotis volans interior* in Colorado. For explanation of symbols, see p. 9.

9.2), 11.18 (9.5-12.1). Selected cranial measurements are presented in table 3.

Remarks.—Lechleitner (1969:56) suspected that *M. volans* occurs state-wide in Colorado. Judging from what is known of the habits of this species, I doubt that future research will support that contention, although the long-legged myotis probably ranges farther eastward in the woodlands of southeastern Colorado and the Platte-Arkansas Divide than has been documented to date.

Miller and Allen (1928:144) noted that Cary (1911:206) had commented on the pallid coloration of Coloradan specimens. The specimens to which Cary referred were from Steamboat Springs and near Meeker and were reported by him as *M. lucifugus longicrus.* These specimens represent *M. l. carissima,* to which subspecies they were referred by Miller and Allen (*op. cit.*:52), as was a specimen from the Conejos River, W of Antonito, also reported by Cary under the name *longicrus.*

Records of occurrence.—Specimens examined, 74, distributed as follows: MOFFAT COUNTY: Hell's Canyon, Dinosaur National Monument, 1 (CU). ROUTT COUNTY: 5 mi. E Toponas, 1 (WC). LARIMER COUNTY: W 1/2, sec. 26, T. 8 N, R. 73 W, 8400 ft., 3 (KU); Fort Collins, 1 (CSU); *Aspenglen Campground,* 1 (RMNP); Moraine Park, 8200 ft., 1 (KU); *YMCA Camp [sec. 4, T. 4 N, R. 73 W],* 1 (RMNP). BOULDER COUNTY: 5 mi. S, 10 mi. W Lyons, 7240 ft., 1 (KU); 3 mi. S, 1/2 mi. W Ward, 9400 ft., 7 (KU); Boulder, 3 (CU). GILPIN COUNTY: Rollinsville, 1 (KU); *S of Rollinsville,* 4 (KU). MESA COUNTY: De Beque Cañon, 1 (CU); Grand Junction, 1 (USNM); Grand Mesa, 28 mi. E Grand Junction, 1 (KU). PARK COUNTY: 2 1/2 mi. S Estabrook, 18 (FHSC). GUNNISON COUNTY: 9 mi. N Crested Butte, 11,000 ft., 1 (KU); *Gothic,* 2 (1 KU, 1 UNM); 4 mi. W Sapinero, 7750 ft., 3 (KU). TELLER COUNTY: Glen Cove, 11,450 ft., 1 (UMMZ). MONTROSE COUNTY: *Jones Summit, Black Canyon of the Gunnison National Monument,* 6 (CU); *Grizzly Gulch,* 3 (CU); 1/2 mi. SE North Rim Headquarters, Black Canyon of the Gunnison National Monument, 1 (CU); Coventry, 1 (USNM). SAGUACHE COUNTY: 5 mi. N, 22 mi. W Saguache, 10,000 ft., 1 (KU); Madenos [Medano] Cañon, above Herard's, 8700 ft., 2 (WC). ALAMOSA COUNTY: Great Sand Dunes National Monument, 1 (GSDNM). MONTEZUMA COUNTY: Rock Springs, Mesa Verde National Park, 7400 ft., 1 (KU). LA PLATA COUNTY: 26 mi. N Bayfield, 1 (AMNH). ARCHULETA COUNTY: Deep Cañon, 2 (UNM). LAS ANIMAS COUNTY: near Wooton, 7500 ft., 2 (UNM).

Additional records: BOULDER COUNTY: *Eldora* (Young, 1908:408). PITKIN COUNTY: near Aspen (Barbour and Davis, 1969:98). GUNNISON COUNTY: *Dry Gulch at Gunnison River, 7400 ft.* (Durrant and Robinson, 1962:242). CONEJOS COUNTY: Conejos (Davis, 1968:49).

Myotis californicus

California Myotis

Myotis californicus is known from scattered localities at lower elevations on the Western Slope, occurring in the Colorado River Valley north and east at least to Rifle. The species occurs throughout much of western North America, from southernmost Alaska and central British Columbia southward to Oaxaca; Coloradan records generally are at the northeastern limits of the range of the California myotis. The species apparently winters in mines and similar situations, in areas to the west and south of Colorado.

Miller and Allen (1928:151) noted how closely variation in *M. californicus* parallels that in *Myotis yumanensis.* They observed further (*op. cit.*:167) that *Myotis leibii* bears a relationship to *M. californicus* comparable to that of *M. lucifugus* to *M. yumanensis.* Similarities are to be seen in variation in color, size, and cranial conformation, and in gross patterns of geographic distribution. A simultaneous consideration of geographic variation in these four species of *Myotis* might prove to be invaluable to our understanding of the evolutionary history and adaptive importance of geographic variation in this notoriously problematic group.

For comparison with *M. leibii,* the small-footed myotis, see the account of that species.

Myotis californicus stephensi Dalquest

Myotis californicus pallidus Stephens, Proc. Biol. Soc. Washington, 13:153, 13 June, 1900; type locality, Vallecito, San Diego Co., California. Not *Myotis pallidus* Hodgson, 1835.

Myotis californicus stephensi Dalquest, Proc. Biol. Soc. Washington, 59:67, 11 March 1946.

Distribution in Colorado.—Known only from western fifth of state (Fig. 22).

Measurements.—External measurements of two males and a female from Mesa Verde National Park are, respectively: 85, 78, 82; 29, 34, 38; 5, 6, 7; 13, 13, 14; 31.4, 32.3, 32.7; a male and a female weighed 3.3 and 4.0, respectively. External measurements of a male

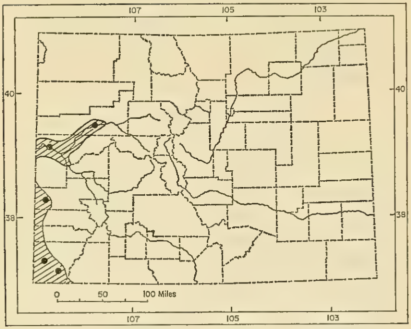


FIG. 22. Distribution of *Myotis californicus stephensi* in Colorado. For explanation of symbols, see p. 9.

from Bedrock, Montrose County, are: 75, 33, 6, —, 32.0. For cranial measurements, see table 3.

Remarks. — Stephens (1900) selected as the holotype of *Myotis californicus pallidus* a specimen (male, original number 2498, F. Stephens) from Vallecito, California (now USNM 99829). The holotype has had a rather involved history, reviewed by Poole and Schantz (1942:151). Dalquest (1946) noted that the name *pallidus* was preoccupied in *Myotis* and proposed the epithet *stephensi* as a replacement name. He then proceeded to redescribe the subspecies, designating as the "type" a different specimen (female, original number 3493, F. Stephens, now MVZ 16657), also from Vallecito, San Diego Co., California. The holotype so designated by Dalquest (*op. cit.*) has no status under the International Code of Zoological Nomenclature, Art. 72(d).

In a number of cases, Coloradan specimens of *Myotis leibii* have been reported in the literature as *M. californicus.* These include specimens from 7 mi. E of Antonito (Cary, 1907a:27); Van Andert's Spring, Little Fountain Creek, and Salida (Warren, 1910b:274); and Marchioness Tunnel, Boulder Canyon (Cary, 1911:208).

Identification of the specimen listed below from Fruita (CU, uncatalogued) is tentative; the skull was not found. External measurements are: 79, 42, 8, 14, 32.0. The specimen is slightly more reddish than an undoubted specimen of *M. californicus* from Bedrock (WC 3016).

Records of occurrence.—Specimens examined, 10, distributed as follows: GARFIELD COUNTY: Rifle, 1 (WC). MESA COUNTY: Aspen Street, Fruita, 1 (CU). MONTROSE COUNTY: Bedrock, 1 (WC). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 3 (USNM); Rock Springs, Mesa Verde National Park, 7400 ft., 2 (KU); *Mesa Verde National Park,* 1 (DMNH); *Loop Road, 1 1/2 mi. S Park Headquarters,* 1 (KU).

Myotis leibii

SMALL-FOOTED MYOTIS

Myotis leibii is widespread in temperate North America and is not uncommon in the West. The species is saxicolous and generally solitary. At present the highest localities of record are 8050 feet, near Crestone, and 7500 feet, near Wooton. Apparently the small-footed myotis over-winters in Colorado. Warren (1942:21) commented on dormant bats in Marchioness Tunnel, 6200 feet, in Boulder Canyon, in late December of 1909. Individuals captured at that time are herein identified as *M. leibii.* In March 1970, Mr. and Mrs. J. S. Altenbach of Colorado State University and I visited an unused diversion tunnel about 5 mi. NW of Livermore. The tunnel was some 150 to 200 meters long, and a maximum of about two meters high; open at both ends, no part of the tunnel was absolutely dark. Air movement through the tunnel was generally brisk, and at 10:30 AM the temperature of still air in the tunnel near the ceiling was 37°F. Roosting in crevices and holes drilled in the rock were individuals of *M. leibii* and also *Eptesicus fuscus* and *Plecotus townsendii.* According to Altenbach, bats are to be found in this and other such tunnels in the vicinity throughout the winter.

Myotis leibii may be confused with *Myotis californicus,* for the species are similar in size. From the California myotis, *M. leibii* differs in having longer dorsal pelage, with prominently burnished tips, larger upper molars, and flatter skull with less abruptly sloping forehead (see Miller and Allen, 1928:166).

Myotis leibii ciliolabrum (Merriam)

Vespertilio ciliolabrum Merriam, Proc. Biol. Soc. Washington, 4:2, 17 December 1886; type locality,

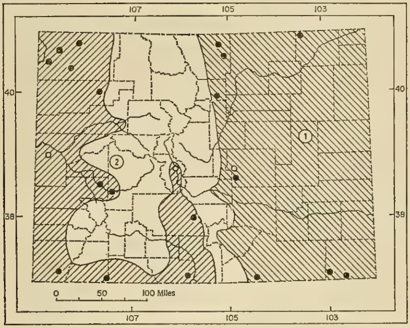


FIG. 23. Distribution of *Myotis leibii* in Colorado. 1. *M. l. ciliolabrum.* 2. *M. l. melanorhinus.* For explanation of symbols, see p. 9.

bluff on Hackberry Creek, about 1 mi. from Castle Rock, near Banner, Trego Co., Kansas.

Myotis leibii ciliolabrum, Glass and Baker, Proc. Biol. Soc. Washington, 81:259, 30 August 1968.

V[espertilio]. subulatus Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 2:65 (footnote), 1823; type locality, near mouth of Apishapa Creek, Otero Co., Colorado. Regarded by Glass and Baker (1968) as *nomen dubium.*

Distribution in Colorado.—Locally in suitable habitat on the eastern plains and along the foothills of the Front Range (Fig. 23).

Comparison.—From M. l. melanorhinus, the subspecies of western Colorado, *M. l. ciliolabrum* differs in paler dorsal and ventral color, the underparts being only slightly or not at all tinged with buff.

Measurements.—External measurements of a male and a female from Larimer County and females from El Paso and Boulder counties are, respectively: 85, 86, 77, 76; 38, 35, 39, 35; 8, 7, 7, 8; 14, 15, —, 12; 32.1, 33.9, 33.0, 30.9. Selected cranial measurements are presented in table 3.

Remarks.—Thomas Say (*in* James, 1823) proposed the name *Vespertilio subulatus* for a bat collected by the expedition of Stephen Long near the confluence of Apishapa Creek and the Arkansas River, in what is now Otero County, Colorado. Whether the specimen described by Say actually was preserved is not known; at any rate, a holotype no longer exists. In the absence of a holotype, the name *subulatus* has been variously misapplied, particularly to the species now known as *Myotis keeni* (see Miller and Allen, 1928:166).

Glass and Baker (1968—also see Glass and Baker, 1965) reviewed the history of the name *subulatus,* corrected misconceptions about the type locality, and suggested that the original description was equivocal. Say's description might apply equally well to the species now known as *Myotis yumanensis* as to *M. subulatus* (*sensu* Miller and Allen, 1928). In particular, one is struck by the fact that Say's specimen was characterized as having ". . . hind-feet rather long, a few setae extending over the nails. . . ." The hair of the dorsum was described as "blackish at base, tip dull cinereus . . ." (*in* James, 1823, 2:65). Both of the characters mentioned above apply better to *M. yumanensis* than to "*subulatus*" in southeastern Colorado. I would agree with Glass and Baker (1968) that the name *subulatus* is unassignable, and adopt their usage of the name *M. leibii* for the small-footed myotis.

A specimen from Van Andert's Spring, Little Fountain Creek, El Paso County (WC 3445), was identified by Warren (1910b:274) as *M. californicus.* This specimen does not exhibit the markedly burnished dorsal hairs characteristic of *M. leibii,* but the skull, although broken, shows the flattened profile typical of that species. In color, the specimen is darker than individuals from farther east, approaching the color of specimens referred herein to *melanorhinus,* as do individuals from a number of localities along the eastern mountain front. A specimen from 30 mi. S of La Junta (DMNH 2788, a female, skull not found) is tentatively identified with *M. l. ciliolabrum;* external measurements are 81, 31, 8, —, 32.4. This bat is catalogued as *Pipistrellus hesperus.*

On the whole, specimens assigned to *M. l. ciliolabrum* are considerably paler dorsally than are specimens from southwestern Colorado herein assigned to *M. l. melanorhinus.* Of specimens examined by me, however, only those from northern Logan County approach closely the pale color of topotypical *ciliolabrum* from Kansas, or specimens from western Nebraska. For further remarks on variation in color in *M. leibii,* see the account of *M. l. melanorhinus.*

Records of occurrence.—Specimens examined, 17, distributed as follows: LARIMER COUNTY: *27 mi. NNW Fort Collins,* 1 (KU); sec. 4, T. 10 N, R. 71 W, 2 (KU); Corbett Hall, Colorado State University, 1 (CSU); *4 mi. SW Fort Collins,* 1 (KU). LOGAN COUNTY: Chimney Cañon, 10 mi. NE Avalo, 2 (USNM). BOULDER COUNTY: *Boulder,* 2 (CU); Marchioness Tunnel, Boulder Canyon, 6200 ft., 2 (WC); *Boulder Canyon,* 1 (CU). EL PASO COUNTY: Van Andert's Spring, Little Fountain Creek, 1 (WC). OTERO COUNTY: 30 mi. S La Junta, 1 (DMNH). LAS ANIMAS COUNTY: near Wooton, 7500 ft., 1 (UNM). BACA COUNTY: Skull Cañon, 1 (CU); Regnier, 1 (DMNH).

Additional records: EL PASO COUNTY: Colorado Springs (Miller and Allen, 1928:169); *Colorado City* (G. M. Allen, 1908:44, as *californicus*).

Myotis leibii melanorhinus (Merriam)

Vespertilio melanorhinus Merriam N. Amer. Fauna, 3:46, 11 September 1890; type locality, Little Spring, 8250 ft., N base of San Francisco Mountain, Coconino Co., Arizona.

Myotis leibii melanorhinus, Glass and Baker, Proc. Biol. Soc. Washington, 81:259, 30 August 1968.

Distribution in Colorado. — At moderate elevations in western three-fifths of state (Fig. 23).

Measurements. — Average (and extreme) external measurements of eight males and four females from Mesa Verde National Park are: 82.0 (81-84), 83.5 (81-88); 37.4 (34-42), 37.2 (33-41); 6.4 (5-8), 6.8 (5-8); 14.4 (13-16), 14.2 (13-15); 32.81 (31.1-34.7), 34.60 (34.3-34.8); weights of three males, 4.6, 5.4, 3.9. Average (and extreme) external measurements of 15 males from Black Canyon of the Gunnison National Monument, Montrose County, are: 81.3 (76-85), 38.7 (34-42), 7.5 (6-9), 14.6 (14-16), 32.97 (31.3-35.2). For cranial measurements, see table 3.

Remarks. — A series of specimens from Mesa Verde National Park shows the rich, reddish brown color typical of populations of western New Mexico, Arizona, and Chihuahua. Individuals from northwestern Colorado tend to be somewhat paler in color, approaching the appearance of animals from Weston and Campbell counties, Wyoming, referred by Long (1965:531) to the subspecies *ciliolabrum.* No specimen from western Colorado is as pallid as those specimens from the Eastern Slope herein referred to *ciliolabrum.* Variation in color across the Great Plains and the Wyoming Basin apparently is clinal.

Records of occurrence.—Specimens examined, 47, distributed as follows: MOFFAT COUNTY: [Little] Snake River, S of Sunny Peak, 2 (USNM); 2 mi. SE Greystone, 4 (CM); Echo Park, 10 mi. N Artesia [Dinosaur], 1 (KU); 1 mi. SW Cross Mountain, 2 (KU). RIO BLANCO COUNTY: Dry Fork, White River, 6200 ft., 1 (AMNH); *6 mi. NE Meeker,* 1 (CM). GUNNISON COUNTY: 4 mi. W Sapinero, 7750 ft., 2 (KU). CHAFFEE COUNTY: Salida, 1 (WC). MONTROSE COUNTY: Jones Summit, Black Canyon of the Gunnison National Monument, 11 (CU); Grizzly Gulch, 1 (CU); *1/2 mi. SE North Rim Headquarters, Black Canyon of the Gunnison National Monument,* 5 (CU). SAGUACHE COUNTY: 1 1/2 mi. N Crestone, 8050 ft., 1 (KU). MONTEZUMA COUNTY: Rock Springs, 7400 ft., Mesa Verde National Park, 5 (KU); *Ruins Road, 1 1/2 mi. S Park Headquarters,* 3 (KU); *Loop Road, 1 1/2 mi. S Park Headquarters,* 4 (KU); *Mesa Verde National Park,* 1 (DMNH). LA PLATA COUNTY: Allison, 1 (UNM). CONEJOS COUNTY: La Manga Creek, 3 mi. N, 18 mi. W Antonito, 1 (UK); 7 mi. E Antonito, 1 (USNM).

Additional records: MESA COUNTY: Monument Mesa, Colorado National Monument, 6620 ft. (P. H. Miller, 1964:31). GUNNISON COUNTY (Durrant and Robinson, 1962:242): *Dry Gulch at Gunnison River, 7400 ft.; Red Creek at Gunnison River, 7400 ft.* CHAFFEE COUNTY: near Buena Vista (Barbour and Davis, 1969:103).

Lasionycteris noctivagans

SILVER-HAIRED BAT

The silver-haired bat roosts in trees and is to be found throughout Colorado, in both the broad-leafed riparian woodland of the eastern plains and the coniferous woodland and forest of higher elevations. Individuals that have been captured on the plains probably were migrants. Actual records of *Lasionycteris noctivagans* above 8000 feet are few, although Elliot Coues captured a specimen (USNM 12827) in "North Park, 10,000 ft." in mid-September 1876, and I have observed individuals foraging slowly at dusk over ponds and wet meadows in western Larimer County at more than 9000 feet. Almost nothing is known of the natural history of this species in Colorado. The silver-haired bat apparently does not over-winter in the state, but migratory patterns are poorly understood. The earliest available record of *L. noctivagans* in spring is 21 March at Boulder and the latest record in autumn is 5 October at Denver.

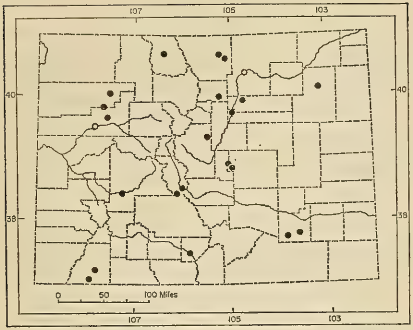


FIG. 24. Distribution of *Lasionycteris noctivagans* in Colorado. For explanation of symbols, see p. 9.

Lasionycteris noctivagans (Le Conte)

V[espertilio]. noctivagans Le Conte, *in* McMurtrie, The animal kingdom . . . by the Baron Cuvier . . . , 1:431, 1831; type locality, eastern United States.

Lasionycteris noctivagans, H. Allen, Bull. U.S. Nat. Mus., 43:105, 14 March 1894.

Distribution in Colorado. — State-wide in suitable habitat (Fig. 24).

Measurements. — Average (and extreme) external measurements of 15 males from 2 1/2 mi. S of Estabrook, Park County, are: 101.1 (95-105), 38.1 (36-40), 8.8 (8-9), 15.1 (14-16), 40.53 (39.0-42.4); weight, 10.85 (9.9-13.2). Cranial measurements are given in table 4.

Records of occurrence.—Specimens examined, 55, distributed as follows: JACKSON COUNTY: North Park, 10,000 ft., 1 (USNM). LARIMER COUNTY: sec. 3, T. 8 N, R. 70 W, 5500 ft., 1 (CSU); Fort Collins, 1 (CU). RIO BLANCO COUNTY: Ute Creek, 8000 ft., 1 (AMNH); White River Plateau, 25 mi. SE Meeker, 8500 ft., 1 (USNM). GARFIELD COUNTY: West Fork Elk Creek, 7722 ft., 8 mi. above New Castle, 1 (USNM). BOULDER COUNTY: Boulder, 1 (CU). ADAMS COUNTY: Barr, 1 (DMNH). DENVER COUNTY: Denver, 3 (1 CSU, 1 CU, 1 DMNH). WASHINGTON COUNTY: Eastern Colorado Range Experiment Station [17 mi. N Akron], 1 (CSU). PARK COUNTY: 2 1/2 mi. S Estabrook, 18 (FHSC). GUNNISON COUNTY: 4 mi. W Sapinero, 7750 ft., 1 (KU). CHAFFEE COUNTY: Salida, 7050 ft., 13 (2 AMNH, 6 CU, 5 WC); Poncha Creek, 9 mi. SW Salida, 8000 ft., 3 (KU). TELLER COUNTY: Green Mountain Falls, 7535 ft., 1 (WC). EL PASO COUNTY: Glen Eyrie, 1 (WC). ALAMOSA COUNTY: 1 1/2 mi. W Alamosa, 1 (ASC). OTERO COUNTY: 12 mi. S Rocky Ford, 1 (CSU); 4 mi. SW Timpas, 1 (CU). LA PLATA COUNTY: Florida, 2 (AMNH); Bondad, 1 (DMNH).

Additional records: WELD COUNTY: Greeley (Warren, 1906:267). GARFIELD COUNTY: Rifle (G. S. Miller, Jr., 1897:87). PARK COUNTY: Montgomery (Blake and Blake, 1969:35).

Pipistrellus hesperus

WESTERN PIPISTRELLE

Pipistrellus hesperus is the smallest of Coloradan bats, and is readily recognized in flight by its erratic, butterfly-like movements in early evening. P. H. Miller (1964) considered this to be the most abundant bat in Colorado National Monument. The biology of this species has not been detailed in Colorado, although Miller (*op. cit.*:33) noted activity throughout the year in Mesa County, save in December, January, and February. Douglas (1967) reported shooting specimens in eastern Montezuma County over a road that passed through a stand of piñon-juniper woodland with scattered sagebrush. Western pipistrelles are generally sedentary, but hibernation in Colorado has not been documented. Elsewhere the bats are known to winter in mines, caves, and fissures.

Pipistrellus hesperus hesperus (H. Allen)

Scotophilus hesperus H. Allen, Smithsonian Misc. Coll., 7 (Publ. 165):43, June 1864; type locality, Old Fort Yuma, Imperial Co., California.

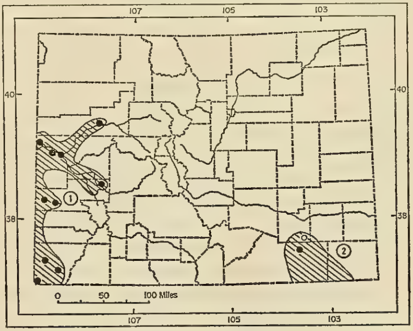


FIG. 25. Distribution of *Pipistrellus hesperus* in Colorado. 1. *P. h. hesperus.* 2. *P. h. maximus.* For explanation of symbols, see p. 9.

TABLE 4

Selected cranial measurements of four species of vespertilionid bats.

Number averaged, sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Mastoid breadth	Interorbital constriction	Length of maxillary toothrow	Length of mandibular toothrow
Lasionycteris noctivagans, 2 1/2 mi. S Estabrook, Park County							
Mean, 15 ♂	16.37	15.63	9.92	8.57	4.27	5.80	—
Minimum	15.9	15.4	9.5	8.4	4.0	5.7	—
Maximum	16.7	15.9	10.2	8.8	4.5	6.0	—
Eptesicus fuscus pallidus, vicinity of Fort Collins, Larimer County							
Mean, 3 ♂	18.20	17.40	10.95	—	4.30	6.77	7.95
Minimum	18.1	16.9	10.7	—	4.2	6.7	7.9
Maximum	18.3	18.0	11.2	—	4.4	6.8	8.0
Mean, 10 ♀	18.54	17.70	12.34	9.78	4.26	6.87	7.89
Minimum	18.3	17.3	11.4	9.3	4.1	6.6	7.8
Maximum	19.7	18.6	13.1	10.2	4.5	7.1	8.5
Lasiurus cinereus cinereus, 2 1/2 mi. S Estabrook, Park County							
Mean, 28 ♂	17.36	16.19	12.18	10.05	5.22	5.93	—
Minimum	16.8	15.6	11.4	9.7	4.9	5.7	—
Maximum	18.0	17.1	12.6	10.5	5.5	6.3	—
Plecotus townsendii pallescens, western Larimer County							
Mean, 4 ♂	16.73	15.28	9.10	—	3.70	5.25	6.70
Minimum	16.7	15.0	9.0	—	3.7	5.2	6.6
Maximum	16.8	15.6	9.2	—	3.7	5.3	6.8
Mean, 6 ♀	16.80	15.37	8.92	—	3.67	5.23	6.65
Minimum	16.6	15.2	8.8	—	3.5	5.2	6.6
Maximum	17.0	15.7	9.0	—	3.9	5.3	6.8

Pipistrellus hesperus, G. S. Miller, Jr., N. Amer. Fauna, 13:88, 16 October 1897.

Distribution in Colorado.—Semiarid canyons of western quarter of state (Fig. 25).

Comparison. — From *P. h. maximus*, the subspecies of northern New Mexico and southeastern Colorado, *P. h. hesperus* differs in paler color and smaller average size both externally and cranially (see measurements).

Measurements.—Mean (and extreme) external measurements of five males from Four Corners, Montezuma County, are: 70.5 (67-75), 30.0 (27-33), 6.0 (5.6-6.8), 30.4 (29.0-31.4). External measurements of two females from Four Corners are: 68, 74; 29, 31; 6, 6; —; 31.8, 31.5. External measurements of three males and two females from Colorado National Monument, Mesa County, are: 70, 67, 70, 75, 70; 30, 29, 28, 28, 32; 6, 6, 5, 5, 5; 12, 12, 14, 12, 13; 30.2, 30.2, 29.4, 30.0, 30.1. Selected cranial measurements of a male and two females from Mesa County include: greatest length of skull, 11.3, 11.8, 11.4; condylobasal length, 11.0, 11.2, 10.9; zygomatic breadth, 7.2, —, —; mastoid breadth, 6.0, 6.3, 6.2; interorbital constriction, 3.0, 3.0, 3.0; length of maxillary toothrow, 4.0, 3.9, 4.1; length of mandibular toothrow, 4.4, 4.7, 4.8.

Remarks. — Hatfield (1936) revised the subspecies of *P. hesperus* and distinguished *P. h. hesperus* from *P. h. santarosae* (=*maximus*) on the basis of smaller size and grayish rather than pale brown color. He examined a single specimen from Colorado, an individual from Bedrock, Montrose County, which was judged to represent an intergrade between *P. h. santarosae* and *P. h. hesperus*, although referable to the former subspecies. Warren (1942) followed this assignment of names. Hall and Dalquest (1950) published a synopsis of American species of *Pipistrellus*, maintaining Hatfield's usage of the name *santarosae* for Coloradan bats and listing Bedrock as a marginal record. This arrangement persisted in Hall and Kelson (1959:182), although specimens from well beyond the range as mapped in Colorado had been reported by Cary (1911:209) as well as Warren (1942: 25).

I have re-examined the specimen from Bedrock, as well as additional material now available from Colorado and comparative material from southern Utah and northern New Mexico. Specimens from western Colorado are a heterogeneous lot. In external size, all fall within the limits of variation of *P. h. hesperus*, but near the upper extreme of that range. The same is true of cranial dimensions.

The color of most specimens is pale grayish brown. Western Colorado (especially the extreme southwestern corner) may, in fact, be an area of intergradation between eastern and western races, as indicated by Hatfield (1936) and subsequent authors, but I think that on the basis of the majority of morphological characteristics, as well as on zoogeographic considerations, pipistrelles from western Colorado are best assigned to *P. h. hesperus.*

After the foregoing remarks were written, Findley and Traut (1970) published a study of geographic variation in *P. hesperus* and revised the infraspecific taxonomy of the species. A pattern of east-west variation in size along an abruptly-stepped cline was described, and two subspecies were recognized. The name *santarosae* was relegated to synonymy under *P. h. maximus* Hatfield, and that usage is followed here. The findings of Findley and Traut (1970) regarding Coloradan pipistrelles are coincident with my conclusions based on less extensive, more localized, data.

Records of occurrence.—Specimens examined, 33, distributed as follows: GARFIELD COUNTY: Rifle, 1 (USNM). MESA COUNTY: Stateline, 1 (CM); *1/2 mi. S Fruita*, 2 (CU); *1 mi. SW Fruita*, 1 (DMNH); Grand Junction, 4 (USNM); *North Monument Cañon, Colorado National Monument*, 1 (CU); *Lower Fruita Reservoir*, 1 (CU); Headquarters, Colorado Monument, 5 (2 CU, 3 CNM); *Colorado National Monument*, 1 (CU). MONTROSE COUNTY: 1/4 mi. N North Rim Entrance, Black Canyon of the Gunnison National Monument, 1 (CU); Bedrock, 1 (WC); Tabeguache Creek, 8 mi. NW Nucla, 1 (USNM). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 1 (USNM); Ruins Road, 1 mi. S Headquarters, 6900 ft., Mesa Verde National Park, 1 (KU); *Loop Road, 1 1/2 mi. S Headquarters*, 2 (KU); *Mesa Verde National Park*, 1 (DMNH); Four Corners, 8 (DMNH).

Additional record: MONTROSE COUNTY: *Paradox* (Burt, 1933:115).

Pipistrellus hesperus maximus Hatfield

Pipistrellus hesperus maximus Hatfield, Jour. Mamm., 17:261, 17 August 1936; type locality, Dog Spring, Hidalgo Co., New Mexico.

Distribution in Colorado.—Probably throughout Raton Section in semiarid canyonlands (Fig. 25).

Comparison.—For comparison with *P. h. hesperus*, the subspecies of the Great Basin and Colorado Plateau, see account of that race.

Measurements.—External and cranial measurements of a male (CU 7591) from eastern Las Animas County are: 70, 24, 7, 13, —; greatest length of skull, 11.8; zygomatic breadth, 7.4; mastoid breadth, 6.6; interorbital constriction, 3.4; length of maxillary toothrow, 4.3; length of mandibular toothrow, 5.0.

Remarks.—The specimen from Las Animas County is a dirty buffy gray dorsally. Prior to preparation, the specimen was preserved in fluid (formalin-phenol-glycerin). For remarks on the effect of that preservative, see the account of *Myotis yumanensis.*

Records of occurrence.—Specimens examined, 2, distributed as follows: OTERO COUNTY: Rock Crossing, 30 mi. S La Junta, 1 (CU). LAS ANIMAS COUNTY: junction of Plum and Chacuacho creeks, 1 (CU).

Eptesicus fuscus

Big Brown Bat

Eptesicus fuscus probably is the commonest Coloradan bat; certainly it is the species most frequently seen by man, because of its habit of roosting in occupied buildings. In addition, individuals may roost in mines, caves, crevices, or even hollow trees. Gillis (1968) studied movements of populations of *E. fuscus* in the Fort Collins area; this work was summarized briefly by Lechleitner (1969: 55). The big brown bat is a year-round resident of the state (see account of *Myotis leibii*).

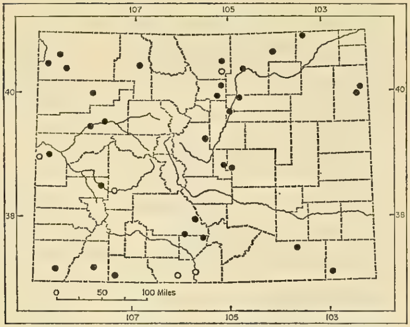


FIG. 26. Distribution of *Eptesicus fuscus pallidus* in Colorado. For explanation of symbols, see p. 9.

Eptesicus fuscus pallidus Young

Eptesicus pallidus Young, Proc. Acad. Nat. Sci. Philadelphia, 60:408, 14 October 1908; type locality, Boulder, Boulder Co., Colorado.

Eptesicus fuscus pallidus, G. S. Miller, Jr., Bull. U.S. Nat. Mus., 79:62, 31 December 1912.

Distribution in Colorado. — Statewide in suitable habitat (Fig. 26).

Comparison.—For comparison with *E. f. fuscus*, the subspecies to the east, see remarks beyond.

Measurements. — Average (and extreme) external measurements of 10 females, followed by measurements of two males, from 1 mi. SW of Fort Collins are: 115.0 (108-123), 105, 116; 48.7 (45-52), 40, 40; 11.4 (11-13), 10, 12; 16.9 (15-18), 16, 14; 47.5 (45-50), 47.0, 47.4; weight, 17.25 (13.9-19.7), 14.6, 17.0. Mean and extreme external measurements of five females from New Castle, Garfield County, are: 110.6 (98-117), 44.8 (43-45), 9.8 (9-11); —; 46.06 (43.7-48.7). Cranial measurements are presented in table 4.

Remarks.—Since the subspecies *E. f. pallidus* was described in 1908, there has been considerable confusion regarding the appropriate subspecific designation of specimens from Colorado, mostly because color was used as a primary diagnostic criterion. Cary (1911:210) noted the wide variability in color of specimens from Colorado, but thought that a single specimen, from Chimney Cañon, Logan County, approached the pale color of *pallidus*: "Although nearly as pale as *pallidus*, this specimen has the measurements of *fuscus*, to which it is referred. Another specimen from Steamboat Springs has the dark coloration of *fuscus*, but in large size approaches *pallidus*." In fact, *E. f. pallidus* averages smaller than *E. f. fuscus* in external and cranial dimensions (Howard, 1967). Warren (1942:26) assigned all Coloradan specimens except those from Boulder to *E. f. fuscus*. Of topotypes of *pallidus*, Warren (1942:27) wrote: "The colors are very decidedly paler than those of any specimen of *E. fuscus* in my collection, though these latter vary considerably among themselves." Engels (1936:657) considered all Coloradan specimens to represent the subspecies *E. f. pallidus* on the basis of color, and Howard (1967) referred Coloradan populations to *pallidus* on the basis of generally small size, pale color, and the tendency of females to bear a single young. Intergradation between *pallidus* and *fuscus* occurs in a broad zone extending through the central Great Plains (see Long and Severson, 1969).

The wide variation in color of individuals captured at the same season may be seen in series examined from New Castle, Fort Collins, and 1 mi. SW of Fort Collins. Individuals with particularly bright pelage were captured 22 September 1952 near Campo, Baca County (KU 50403) and 23 August 1956 in Mesa Verde National Park (KU 69253).

Records of occurrence.—Specimens examined, 137, distributed as follows: MOFFAT COUNTY: 2 mi. SE Greystone, 4 (CM); *Douglas Spring*, 1 (WC); Castle Park, Dinosaur National Monument, 5 (CU); N bank Yampa River, 4 mi. NW Cross Mountain, 1 (AMNH). ROUTT COUNTY: Steamboat Springs, 1 (USNM). LARIMER COUNTY: Fort Collins, 5015 ft., 25 (CSU); *1 mi. SW Fort Collins*, 12 (KU). WELD COUNTY: 12 mi. NW New Raymer, 1 (CU); Greeley, 1 (CU). LOGAN COUNTY: Chimney Cañon, 10 mi. NE Avalo, 1 (USNM). RIO BLANCO COUNTY: Meeker, 1 (USNM). GARFIELD COUNTY: New Castle, 5375 ft., 19 (1 AMNH, 18 WC); Lacy, 2 (FMNH). BOULDER COUNTY: Longmont, 2 (CU); *Sunshine*, 1 (CU); *Boulder*, 17 (14 CU, 1 KU, 2 USNM); Boulder Canyon, 1 (CU). ADAMS COUNTY: Barr, 1 (DMNH). DENVER COUNTY: Denver, 5 (1 AMNH, 1 CU, 1 DMNH, 1 FWS, 1 KU); Globeville, 1 (DMNH). YUMA COUNTY: Wray, 2 (DMNH); Dry Willow Creek, 1 (DMNH). MESA COUNTY: Colorado National Monument, 4 (CU); *1/4 mi. W Glade Park Road on Rim Rock Drive*, 1 (CNM). PARK COUNTY: 2 1/2 mi. SW Estabrook, 3 (FHSC). TELLER COUNTY: Glen Cove, 1 (UMMZ). EL PASO COUNTY: Colorado Springs, 3 (1 AMNH, 2 WC). MONTROSE COUNTY: *Jones Summit, Black Canyon of the Gunnison National Monument,* 7 (CU); 1/2 mi. SE North Rim Headquarters, Black Canyon of the Gunnison National Monument, 1 (CU); Black Canyon of the Gunnison National Monument, 1 (CNM). SAGUACHE COUNTY: 1 1/2 mi. N Crestone, 8050 ft., 1 (KU); 9 mi. E Center, 1 (AMNH). ALAMOSA COUNTY: Mosca Creek Pond, 1 (GSDNM); *Great Sand Dunes National Monument,* 8100 ft., 1 (GSDNM). MONTEZUMA COUNTY: Rock Springs, Mesa Verde National Park, 1 (KU). LA PLATA COUNTY: Florida, 1 (AMNH). ARCHULETA COUNTY: Deep Cañon, 1 (UNM). LAS ANIMAS COUNTY: junction of Plum and Chacuacho creeks, 2 (CU). BACA COUNTY: 2 mi. N, 19 mi. W Campo, 1 (KU).

Additional records: LARIMER COUNTY: Loveland (G. S. Miller, Jr., 1897:98). MESA COUNTY: Little Dolores River (P. H. Miller, 1964:35). GUNNISON COUNTY: Dry Gulch at Gunnison River (Durrant and Robinson, 1962:242). CONEJOS COUNTY: Conejos (Davis, 1968:49); Rio Grande (Coues and Yarrow, 1875:92).

Lasiurus borealis

RED BAT

The red bat ranges throughout much of temperate and subtropical North America and is abundant in some areas. In Colorado, however, it apparently never has been common. Red bats roost singly in trees or shrubs and evidently are confined to riparian communities in the eastern part of the state. The present status of *Lasiurus borealis* in Colorado is not known. The most recent recorded capture in the state is August 1911 (Warren, 1912a:7). As in adjacent plains states, *L. borealis* is a summer resident, migrating southward in winter. The red bat is known from a number of localities in western Kansas, records being available from along the Arkansas River in Hamilton County, as well as from the High Plains at Hays (Jones *et al.,* 1967:17). Records from western Nebraska are few (Jones, 1964:95).

Lasiurus borealis borealis (Müller)

Vespertilio borealis Müller, Des Ritters Carl von Linne . . . vollständiges Natursystem. . . , Suppl., p. 20, 1776; type locality, New York.

Lasiurus borealis, G. S. Miller, Jr., N. Amer. Fauna, 13:105, 16 October 1897.

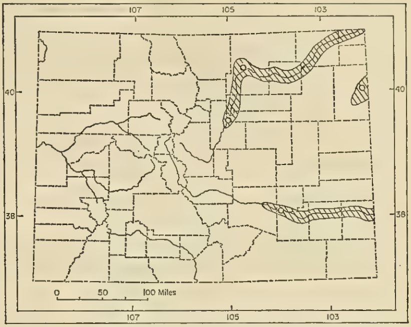


FIG. 27. Distribution of *Lasiurus borealis borealis* in Colorado. For explanation of symbols, see p. 9.

Distribution in Colorado. — Known only from wooded areas in valleys of South Platte and Arkansas rivers (Fig. 27).

Comparison.—From *L. b. teliotis,* a subspecies of the desert Southwest and the Pacific Coast, *L. b. borealis* differs in larger cranial size, larger ear with pronounced basal lobe, and generally duller color (G. S. Miller, Jr., 1897:111).

Measurements.—External measurements of two males, and mean (and extreme) measurements of eleven females, all from the vicinity of Lawrence, Douglas Co., Kansas, are (Cockrum, 1952:77): 103, 110, 113.7 (109-124); 48, 47, 52.5 (50-60); 9, 9, 9.5 (9-10); 12, 12, 12.5 (12-13). Cranial measurements of two males and three females from the same locality include (Cockrum, *op. cit.*:87): greatest length of skull, 13.5, 13.9, 13.7, 13.7, 13.7; condylobasal length, 13.5, 13.9, 13.7, 13.7, 13.7; zygomatic breadth, 9.5, 9.8, 10.0, 9.7, 9.8; interorbital constriction, 4.3, 4.5, 4.5, 4.2, 4.3; breadth of braincase, 7.8, 8.2, 8.3, 7.8, 8.3; length of maxillary toothrow, 4.0, —, 3.8, 3.9, 4.2; length of mandibular toothrow, 6.5, 6.3, 6.4, 6.2, 6.6.

Remarks.—My knowledge of the distribution of *L. borealis* in Colorado is based entirely on records in the literature; specimens upon which these reports were based no longer are to be found. According to Lechleitner (1969:55), there are published records of red bats from Boulder and Larimer counties, but I am unaware of the reports to which he refers. J. A. Allen (1874:56), working near Montgomery on Mount Lincoln in 1871, wrote: "A small bat was a few times seen flying about camp soon after sunset, which was probably *Lasiurus Noveboracensis* [= *L. borealis*]." More probably the bat Allen saw was *Lasionycteris noctivagans*.

Records of occurrence.—Specimens examined, none.

Additional records: WELD COUNTY: Greeley (Warren, 1906:268). ARAPAHOE COUNTY: NW of Littleton (Warren, 1912a:7). YUMA COUNTY: Wray (Warren, *loc. cit.*). OTERO COUNTY: mouth of Apishapa Creek (Say, *in* James, 1823, 2:65; locality fixed by Glass and Baker, 1968).

Lasiurus cinereus

Hoary Bat

The hoary bat is widespread in Colorado, and males are not uncommon along the eastern flank of the mountains and at lower elevations on the Western Slope. Individuals roost in trees. *Lasiurus cinereus* is migratory, but details of its natural history are unknown. Although specimens seldom have been captured on the plains of eastern Colorado, migratory indviduals are to be expected there in riparian woodlands. Jones (1964:96) indicated that the hoary bat probably occurs state-wide in Nebraska. A migrant *L. cinereus* was captured in early spring in Cheyenne County, Kansas (Jones *et al.*, 1967:21), within 10 miles of the Colorado boundary.

Lasiurus cinereus is readily distinguished from other Coloradan bats by its large size, the white-tipped hairs of the dorsum, the heavily-furred uropatagium, and the rounded, black-rimmed ears.

Lasiurus cinereus cinereus

(Palisot de Beauvois)

Vespertilio cinereus (misspelled "*linereus*") Palisot de Beauvois, Catalogue raisonné de muséum de Mr. C. W. Peale, Philadelphia, p. 18, 1796; type locality, Philadelphia, Philadelphia Co., Pennsylvania.

Lasiurus cinereus, H. Allen, Smithsonian Misc. Coll. 7 (Publ. 165):21, June 1864.

Distribution in Colorado.—Probably throughout the state as migrants or summer residents in suitable habitat at lower and middle elevations (Fig. 28).

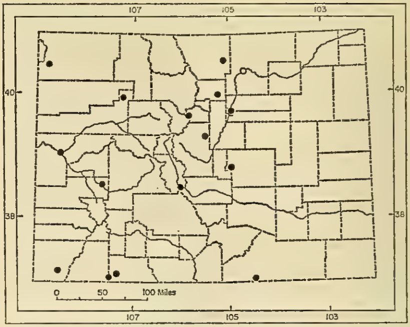


FIG. 28. Distribution of *Lasiurus cinereus cinereus* in Colorado. For explanation of symbols, see p. 9.

Measurements.—Mean (and extreme) measurements of 28 males from 2 1/2 mi. S of Estabrook, Park County, are: 133.1 (123-142), 53.4 (51-60), 11.1 (9-12), 16.5 (13-18), 52.33 (50.0-55.6); weight, 27.41 (24.3-32.1). A. M. Bailey (1937) reported a lactating female taken on 25 June 1936 that weighed 20.8; her two suckling male offspring weighed 13.87 and 14.12. For cranial measurements, see table 4.

Records of occurrence.—Specimens examined, 66, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 1 (CU). LARIMER COUNTY: Fort Collins, 2 (1 CSU, 1 UMMZ). GARFIELD COUNTY: Trappers Lake, 9600 ft., 1 (CU). BOULDER COUNTY: *7 mi NE Boulder,* 1 (CU); *Valmont Road, Boulder,* 1 (CU); Boulder, 3 (CU); *S of Boulder,* 1 (CU); *no locality other than county,* 1 (USNM). CLEAR CREEK COUNTY: Loveland Pass, 1 (DMNH). DENVER COUNTY: Denver, 6 (1 CSU, 5 DMNH). PARK COUNTY: 2 1/2 mi. S Estabrook, 33 (FHSC). CHAFFEE COUNTY: Salida, 1 (WC). MONTROSE COUNTY: Jones Summit, Black Canyon of the Gunnison National Monument, 2 (CU); *Black Canyon of the Gunnison National Monument,* 1 (CNM). MONTEZUMA COUNTY: 1/2 mi. N North Rim, Chapin Mesa, Mesa Verde National Park, 1 (KU). LA PLATA COUNTY: Allison, 2 (UNM). ARCHULETA COUNTY: Deep Cañon, 5 (UNM). LAS ANIMAS COUNTY: near Wooton, 7500 ft., 3 (UNM).

Additional records: WELD COUNTY: Greeley (Warren, 1906:268). MESA COUNTY: Grand Junction (Warren, 1942:28). EL PASO COUNTY: Colorado Springs (Warren, *loc. cit.*). ARCHULETA COUNTY: *5 mi. N Arboles* (Durrant and Dean, 1961:164).

Plecotus townsendii

Townsend's Big-eared Bat

Plecotus townsendii is a species of western North America, ranging throughout Colorado except for the eastern plains. The extreme elevation from which specimens are available is about 9500 feet, at Gothic, Gunnison County. Townsend's big-eared bat roosts in caves, shaft mines, and occasionally in buildings. Lechleitner (1969:52) presented some details on the species in the vicinity of Fort Collins, but in general the life history of the bat in Colorado is unknown. Handley (1959) revised the taxonomy of American species of *Plecotus* and reviewed the literature on natural history.

Because of their tendency to gather in maternity and hibernating colonies, populations of *P. townsendii* are particularly vulnerable to wanton molestation by humans. This is especially true in Colorado where extensive natural caverns are few and hard-rock mines, generally readily accessible to man, are the most commonly available roosting sites. In the summer of 1969, I was told by residents of Moffat in the San Luis Valley that extensive colonies of big-eared bats had been present in the mines in North Crestone Canyon, but they had been disturbed frequently by local youngsters. Extensive search in the area revealed no recent evidence of cavernicolous bats.

Plecotus townsendii pallescens

(G. S. Miller, Jr.)

Corynorhinus macrotis pallescens, G. S. Miller, Jr., N. Amer. Fauna, 13:52, 16 October 1897; type locality, Keam Canyon, Navajo Co., Arizona.

Plecotus townsendii pallescens, Handley, Proc. U.S. Nat. Mus., 110:190, 3 September 1959.

Distribution in Colorado.—In suitable habitat in western, central, and southeastern parts of state (Fig. 29).

Measurements.—Mean (and extreme) external measurements of five males, followed by those of six females, all from Larimer County, are: 91.8 (82-100), 96.3 (87-102); 43.6 (35-50), 45.0 (38-51); 10.2 (9-12), 11.0 (10-12); 33.6 (30-37), 35.8 (34-38); 42.83 (39.0-44.5), 43.58 (42.4-44.7); weight, 10.50 (9.0-11.5), 12.38 (10.0-14.0). Cranial measurements are included in table 4.

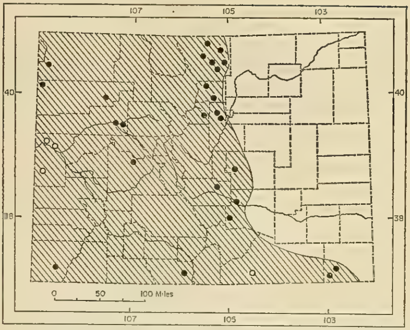


FIG. 29. Distribution of *Plecotus townsendii pallescens* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 92, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 1 (CU). LARIMER COUNTY: Cherokee Park, 1 (CU); *5 mi. NW Livermore, 6700 ft.*, 1 (CSU); *34 mi. NW Fort Collins*, 1 (CSU); *22 mi. NW Fort Collins*, 1 (CSU); limestone cave, Owl Canyon, 2 (CSU); *1/4 mi. N Owl Canyon Store*, 1 (CSU); *20 mi. NW Fort Collins*, 1 (CSU); *9 mi. N, 5 mi. W Fort Collins, 5300 ft.*, 1 (CSU); *sec. 20, T. 9 N, R. 73 W*, 1 (CSU); Rustic, 8000 ft., 2 (CSU); *26 mi. W Laporte, 7000 ft.*, 1 (CSU); *14 mi. W Laporte*, 2 (CSU); *12 mi. W Laporte*, 1 (CSU); *Rist Canyon*, 1 (CSU); *Sevenmile Creek, 40 mi. W Fort Collins*, 2 (CSU); *14 1/2 mi. W Fort Collins, 6500 ft.*, 2 (CSU); 14 mi. W Fort Collins, 1 (CSU); Fort Collins, 1 (CSU); Masonville, 2 (CSU). RIO BLANCO COUNTY: 5 mi. N, 10 mi. W Rangely, 5800 ft., 1 (KU); Spring Cave, near Buford, 1 (CU). GARFIELD COUNTY: Fairy Cave, Iron Mountain, near Glenwood Springs, 1 (CU); Hubbard's Cave, 1/2 mi. S Shoshone Power Plant, Glenwood Canyon, 4 (CU). BOULDER COUNTY: 12 mi. W Lyons, 7760 ft., 1 (CU); 1 mi. S, 5 mi. W Boulder, 1 (CU); *Boulder Canyon, 7000 ft.*, 1 (CU). CLEAR CREEK COUNTY: 2 mi. NW Idaho Springs, 1 (CU). JEFFERSON COUNTY: Golden, 21 (DMNH); Red Rocks Park, 10 (8 DMNH, 2 KU). GUNNISON COUNTY: Gothic, 1 (UNM). EL PASO COUNTY: *Cave of the Winds*, 1 (AMNH); Colorado Springs, 4 (AMNH). FREMONT COUNTY: 10 mi. N Cañon City, 1 (CU); *Fly Cave*, 10 (CU). PUEBLO COUNTY: Swallows, 1 (SCSC); Buelah, 1 (CU). MONTEZUMA COUNTY: Rock Springs, 7400 ft., Mesa Verde National Park, 1 (KU); *Square Tower House, 6700 ft.*, 1 (KU). CONEJOS COUNTY: Manassa, 1 (GSDNM). BACA COUNTY: Jimmie Creek, 1 (DMNH); 2 mi. N, 19 mi. W Campo, 1 (KU).

Additional records: BOULDER COUNTY: *12* *mi. S Lyons* (G. M. Allen, 1916:341); *Crisman, Fourmile Canyon, 7000 ft.* (Cary, 1911:204); *Boulder Canyon, 7700 ft.* (R. T. Young, 1908:407). MESA COUNTY (P. H. Miller, 1964:36): 4 mi. N Loma, 4659 ft.; 2 mi. NE Fruita, 4500 ft.; Unaweep Canyon. EL PASO COUNTY: *1 mi. N Glen Eyrie* (Warren, 1942:30). LAS ANIMAS COUNTY: Trinidad (Warren, 1906:267).

Antrozous pallidus

Pallid Bat

The pallid bat apparently is restricted in Colorado to the semiarid canyonlands of the Western Slope, and broken, rocky areas in the southeastern part of the state, south of the Arkansas River. Pallid bats typically roost in fissures in rocks, but may also occupy buildings. The status and natural history of *Antrozous pallidus* in Colorado are poorly known, but individuals generally are sedentary, and probably the species winters in the state.

Antrozous pallidus pallidus (Le Conte)

V[espertilio]. pallidus Le Conte, Proc. Acad. Nat. Sci. Philadelphia, 7:437, 1856; type locality, El Paso, El Paso Co., Texas.

Antrozous pallidus, H. Allen, Smithsonian Misc. Coll., 7 (Publ. 165):68, June 1864.

Distribution in Colorado.—Semiarid canyons of western and southeastern parts of state (Fig. 30).

Measurements. — External and cranial measurements of two females (CU, uncatalogued) from Mesa County are: 119, 116; 52, 53; 11, 10; 36, 36; 56.2, 57.8; condylobasal length, 19.1, 19.4; zygomatic breadth, 12.7, 12.8; interorbital constriction, 4.1, 4.1; mastoid breadth, 9.8, 9.9; length of maxillary toothrow, 6.9, 7.5; length of mandibular toothrow, 8.6, 9.1.

Remarks. — Lechleitner (1969:53) noted that "one should be careful of identifications of bats from southeastern Colorado as it is extremely possible that Bunker's bat, *Antrozous bunkeri*, occurs in that area. . . ." Morse and Glass (1960), however, regarded *bunkeri* as a subspecies of *A. pallidus*, and restricted the range of the subspecies to the rocky canyonlands of Barber County, Kansas, and adjacent Oklahoma, south to the Wichita Mountains, southwestern Oklahoma. The range of *A. p. bunkeri* is thus apparently isolated from that of *A. p. pallidus* of Colorado and the adjacent Oklahoma Panhandle by a considerable space of unsuitable plains habitat.

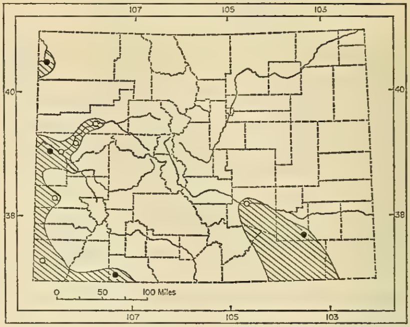


FIG. 30. Distribution of *Antrozous pallidus pallidus* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 6, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 2 (CU). MESA COUNTY: East Monument Cañon, 4800 ft., Colorado National Monument, 2 (CU). OTERO COUNTY: 3 mi. NW Higbee, 4300 ft., 1 (KU). ARCHULETA COUNTY: Deep Cañon, 1 (UNM).

Additional records: GARFIELD COUNTY: 7 mi. W Rifle (Cary, 1911:206). MESA COUNTY: *Crevasse* (Cary, *loc. cit.*); 5 mi. E Tunnel (Cary, *loc. cit.*); Redlands Club House, Grand Junction, 4800 ft. (P. H. Miller, 1964:37). MONTROSE COUNTY: Tabeguache Creek, N of Nucla (Cary, *loc. cit.*). PUEBLO COUNTY: Pueblo (Coues and Yarrow, 1875:85). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui] (Cary, 1907b:85).

Family Molossidae—Free-tailed Bats

Tadarida brasiliensis

Brazilian Free-tailed Bat

Tadarida brasiliensis is a highly colonial species, the breeding range of which lies generally to the south of Colorado. Molossids are strong, fast fliers, and the occasional records of this species in Colorado probably represent wandering individuals from breeding colonies to the south or southeast in Oklahoma, Texas, New Mexico, or Arizona. Date of capture of five specimens at New Castle was 24 July 1907, whereas that of a male from Mesa Verde was 23 August 1936.

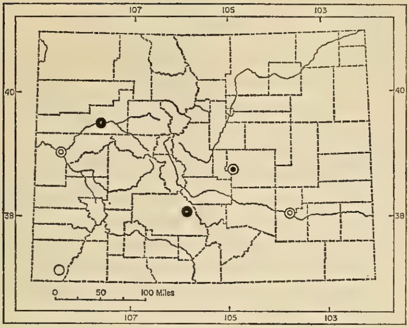


FIG. 31. Distribution of two species of free-tailed bats in Colorado. Single symbols, *Tadarida brasiliensis mexicana*; concentric symbols, *Tadarida macrotis*.

Tadarida brasiliensis mexicana (Saussure)

Molossus mexicanus Saussure, Revue et Mag. Zool., Paris, ser. 2, 12:283, July 1860; type locality, Cofre de Perote, 13,000 ft., Veracruz.

Tadarida brasiliensis mexicana, Schwartz, Jour. Mamm., 36:108, 28 February 1955.

Distribution in Colorado. — Known from but three localities in southern and western parts of state (Fig. 31).

Measurements.—External measurements of four males from New Castle, Garfield County, are: 102, 97, 101, 102; 34, 33, 38, 34; 11, 10, 10, 10; —; 43.2, 42.7, 44.0, 43.3. Cranial measurements of one of these individuals (WC 2545) include: condylobasal length, 16.3; zygomatic breadth, 9.8; mastoid breadth, 9.6; interorbital constriction, 3.9; maxillary toothrow, 5.7; mandibular toothrow, 7.0.

Records of occurrence.—Specimens examined, 6, distributed as follows: GARFIELD COUNTY: New Castle, 5 (WC). SAGUACHE COUNTY: near Mineral Hot Springs, 1 (GSDNM).

Additional record: MONTEZUMA COUNTY: Cliff Palace, 6800 ft., Mesa Verde National Park (Anderson, 1961:39).

Tadarida macrotis

BIG FREE-TAILED BAT

Tadarida macrotis commonly roosts in crevices among rocks and is not as highly colonial as the smaller, cavernicolous *Tadarida brasiliensis.* Although the big free-tailed bat has been captured as far north as British Columbia and Iowa, breeding populations of *T. macrotis* in the United States are confined to the Southwest, particularly Texas, New Mexico, and Arizona. Big free-tailed bats are strong fliers and the specimens from Colorado doubtless represent wandering individuals from breeding colonies farther south. The specimen from Colorado Springs is a female, captured on 4 October 1937 (see Smead, 1938), and that from Rocky Ford is a male, captured on 13 October 1959.

Tadarida macrotis (Gray)

Nyctinomus macrotis Gray, Ann. Nat. Hist., 4:5, September 1839; type locality, Cuba.

Tadarida macrotis, Shamel, Proc. U.S. Nat. Mus., 78:15, 6 May 1931.

Distribution in Colorado.—Three scattered records from both east and west of the Continental Divide (Fig. 31).

Measurements.—External measurements of a male from El Paso County (DMNH 3084) are: 130, 52, 16, 10, 60.0 (fresh—58.6 dry). The single specimen that I have examined was without accompanying skull.

Remarks.—The nomenclatorial history of *T. macrotis* was reviewed by Husson (1962).

Records of occurrence.—Specimens examined, 1, as follows: EL PASO COUNTY: Cheyenne Cañon, Colorado Springs, 1 (DMNH).

Additional records: MESA COUNTY: Grand Junction (Warren, 1906:268). OTERO COUNTY: Rocky Ford (Constantine, 1961a:405).

Order LAGOMORPHA

Coloradan lagomorphs represent three genera and seven species. Every part of the state is occupied by at least one of those species, and where ecological conditions allow, two or more may be grossly sympatric. In general, however, save in the case of *Lepus townsendii* and *Lepus californicus* in areas recently occupied by the latter species, pronounced ecological differences are to be seen between the species.

The pika, *Ochotona princeps,* is unmistakable in appearance and in habitat. Distinguishing between the three species of *Sylvilagus* in Colorado is difficult in the field. Characteristics of habitat are as constant and useful as any external feature in identifying the two woodland species, *Sylvilagus nuttallii* and *Sylvilagus floridanus*. The skulls of cottontails are readily identified, particularly if comparative reference material is available. Odd skulls of jackrabbits, *Lepus californicus* or *Lepus townsendii*, may be difficult to determine to species, and characters used in the key below are hardly infallible, especially in western Colorado. Externally, species of *Lepus* are, of course, readily distinguished.

KEY TO SPECIES OF LAGOMORPHA IN COLORADO

1. Pinna as broad as long, rounded, no visible tail; premolars 2/2, total teeth 26 .... *Ochotona princeps*

   Pinna long, tail short but obvious; premolars 3/2, total teeth 28 2

2. Interparietal bone distinct; length of hind foot typically less than 105 3

   Interparietal bone fused to parietal in adult, indistinct; length of hind foot typically greater than 130 5

3. Auditory bullae notably large, as long as basioccipital or nearly so, surface rugose; ground color of dorsum pale, grayish to buff .... *Sylvilagus audubonii*

   Auditory bulla small to moderate in size, shorter than basioccipital, surface generally smooth; ground color of dorsum bright, generally reddish 4

4. Auditory bulla smaller, diameter of external auditory meatus less than crown length of upper molars; inside of pinna not densely furred; habitat in and near deciduous riparian woodland of eastern plains .... *Sylvilagus floridanus*

   Auditory bulla larger, diameter of external auditory meatus greater than crown length of upper molars; inside of pinna densely furred; habitat in and near coniferous woodlands or montane streambank communities .... *Sylvilagus nuttallii*

5. No anterior projection on supraorbital process, greatest length of skull less than 80; length of ear less than 75 .... *Lepus americanus*

   Prominent anterior projection on supraorbital process; greatest length of skull greater than 90; length of ear greater than 100 6

6. Skull relatively highly arched, rostrum relatively short, deep, anterior groove on upper incisor (viewed from occlusal surface) simple; tail white, or if gray or black caudal line present, the black not extending onto back .... *Lepus townsendii*

   Skull relatively low and flattened, rostrum relatively long, shallow, anterior groove of upper incisor (viewed from occlusal surface) furcate; tail black, the black patch extending onto back .... *Lepus californicus*

FAMILY OCHOTONIDAE—PIKAS

Ochotona princeps

PIKA

Pikas occur widely in the higher mountains of western North America and in Colorado are to be found on all principal mountain ranges, and on lesser uplifts where habitat is suitable. The species occurs primarily at high elevations, typically near and above timberline, but—as is usual among mammals—suitable cover and forage, not elevation *per se*, determine local distribution. All specimens examined were captured at elevations of 8500 feet or higher. Talus slopes are preferred habitat. A source of forbs and grasses nearby is necessary both for immediate use and for storage in characteristic "haypiles" for winter food. Beidleman and Weber (1958) analyzed the contents of a pika haypile in Rocky Mountain National Park, and Johnson and Maxell (1966) described daily food intake and assimilation in pikas of the San Juans.

Much popular literature has been written concerning the habits of pikas (for example, Warren 1928b). Largely diurnal, they are readily located by their alarm cries and nervous movements, and are excellent subjects for behavioral observations. Krear (1965) studied behavior and population dynamics of pikas on Niwot Ridge, Boulder County. Anthony (1923) described supposed emigration in Coloradan pikas. D. R. Johnson (1967) presented notes on diet and reproductive activity in southwestern Colorado, and Hayward (1952) presented reproductive data on pikas

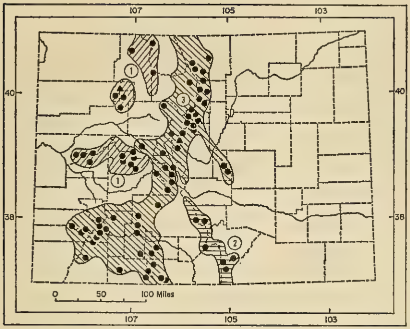


FIG. 32. Distribution of *Ochotona princeps* in Colorado. 1. *O. p. figginsi.* 2. *O. p. incana.* 3. *O. p. saxatilis.* For explanation of symbols, see p. 9.

from Gunnison County. Dice (1927) detailed problems of maintaining pikas in captivity, and F. W. Miller (1939) described a technique for capturing the animals alive.

The subspecies of *Ochotona princeps* were revised by A. H. Howell (1924). This revision is generally followed in the accounts of subspecies below, although a new assessment of geographic variation over the range of the species is needed. Where adequate samples are available for comparison, subspecies are seen to differ principally in cranial dimensions. There is considerable variation in external measurements, but pikas are difficult to measure, and some of the variation must be ascribed to error by collectors and differences in technique. Color has been used extensively in subspecific descriptions, but variation in color of pikas is particularly refractory to analysis because of the complexity of the molt and the patent tendency of the hairs to rapid wear. Thus, assignment of individual specimens to subspecies on the basis of color is necessarily rather arbitrary and even series of specimens may be difficult to allocate with any degree of confidence.

Ochotona princeps figginsi J. A. Allen

Ochotona figginsi J. A. Allen, Bull. Amer. Mus. Nat. Hist., 31:103, 28 May 1912; type locality, Pagoda Peak, Rio Blanco Co., Colorado.

Ochotona princeps figginsi, A. H. Howell, N. Amer. Fauna, 47:21, 21 August 1924.

Distribution in Colorado.—Mountains and high plateaus of western part of state, from Park Range southward to Elk and West Elk mountains (Fig. 32).

Comparisons.—From *O. p. saxatilis,* the subspecies of the Front Range, *O. p. figginsi* differs in slightly smaller average external and cranial size, and in generally darker, more vinaceous color in summer pelage. For extended comparison, see Henderson and Cockerell (1913).

From *O. p. nigrescens,* the subspecies of the Jemez Mountains, *O. p. figginsi* differs in slightly larger external and cranial size and paler color, the pelage in summer being less heavily washed with black.

Measurements.—External measurements of two males and two females from near the type locality are: 178, 187, 184, 197; 9, 8, 10, 9; 31, 31, 31, 31; 23, 24, 23, 25. External measurements of two females from the Grand Mesa are: 201, 190; —; 21, —; 19, 19. A male and female from Mesa County weighed 211 and 189, respectively. Selected cranial measurements are presented in table 5.

Remarks.—*Ochotona p. figginsi* shows less variability over its range than does *O. p. saxatilis,* yet *figginsi* is a zoogeographic anomaly, showing an apparently polytopic distribution. All westward-trending ranges and high plateaus of the Western Slope are populated by pikas referable on morphologic grounds to *figginsi.* However, "gene flow" must be minimal between discontinuous populations in the 1) Park Range and Elkhead Mountains, 2) the White River Plateau, and 3) the Grand Mesa and Elk and West Elk mountains. Probably this apparent anomaly is in part a reflection of our inadequate knowledge of distribution of pikas in Pitkin and Eagle counties.

Pruitt (1954) considered specimens from Gothic to be intergrades between *figginsi* and *saxatilis;* specimens from northern Gunnison County in general are intermediate between the two subspecies.

Records of occurrence.—Specimens examined, 102, distributed as follows: ROUTT COUNTY: Sand Mountain, 1 (USNM). JACKSON COUNTY: Mount Zirkel, 7 (DMNH); *Baldy Mountain, near Mount Zirkel,* 3 (WC). RIO BLANCO COUNTY: *1 mi. NW Pagoda Peak, 10,400 ft.,* 11 (KU); Pagoda Peak, 14 (2 AMNH, 11 DMNH, 1 USNM); Papoose

TABLE 5

Selected cranial measurements of three subspecies of *Ochotona princeps.*

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Interorbital constriction	Postorbital constriction	Least length of palatal bridge	Depth of skull	Breadth of braincase	Length of nasals
Ochotona princeps figginsi, Trappers Lake and Pagoda Peak								
Mean, 6 ♂	43.78	41.47	5.32	14.08	2.28	18.12	16.43	14.68
Minimum	41.6	39.5	4.9	13.6	2.0	17.5	16.1	13.7
Maximum	46.2	42.8	5.7	14.4	2.8	19.0	17.0	15.4
Mean, 4 ♀	42.98	40.75	5.30	14.44	2.00	17.60	16.63	14.18
Minimum	42.1	39.9	4.9	13.8	1.9	17.2	16.5	13.5
Maximum	43.7	42.8	5.6	14.7	2.1	18.2	16.9	14.8
Ochotona princeps incana, Sangre de Cristo Range, S of La Veta Pass								
Mean, 5 ♂	45.20	42.10	5.38	14.20	2.00	18.33	17.03	15.10
Minimum	43.8	40.8	5.1	14.0	1.7	17.4	16.2	14.9
Maximum	46.0	42.8	5.7	14.5	2.5	19.3	17.7	15.4
CU 4845, ♀	44.2	——	5.5	13.9	2.6	17.4	——	14.8
Culebra Range and Spanish Peaks								
CU 4843, ♂	44.5	42.0	5.1	13.9	1.8	17.6	16.9	15.1
CU 4855, ♂	44.1	——	4.9	14.2	1.8	18.5	——	15.3
CU 4844, ♀	42.3	——	5.8	14.5	——	17.6	16.5	13.8
Ochotona princeps saxatilis, northwestern Park County								
Mean, 5 ♂	44.50	41.40	5.60	14.36	2.60	18.27	16.20	14.98
Minimum	43.0	39.8	5.3	14.1	2.3	16.9	15.8	14.8
Maximum	46.1	43.7	5.9	14.6	3.2	19.7	16.6	15.3
Mean, 5 ♀	44.42	41.80	5.56	13.62	2.30	17.20	16.20	15.06
Minimum	43.6	41.2	5.0	13.2	1.6	16.6	15.7	14.6
Maximum	45.8	43.0	6.2	14.0	3.5	17.5	16.8	15.8

[Basin] 9000 ft., 6 (AMNH). GARFIELD COUNTY: *1 mi. NW Trappers Lake,* 6 (CM); Trappers Lake, 10 (WC); Deep Lake, 16 mi. N Glenwood Springs, 1 (KU). MESA COUNTY: Grand Mesa, 28 mi. E Grand Junction, 2 (KU). PITKIN COUNTY: 15 mi. SW Aspen, 10,000 ft., 1 (CSU). DELTA COUNTY: *11 1/2 mi. S, 5 1/2 mi. E Collbran, 10,200 ft.,* 1 (KU); 12 mi. S, 5 1/2 mi. E Collbran, 10,200 ft., 1 (KU); 6 mi. E Skyway, 10,500 ft., 1 (KU); *7 mi. E Skyway, 10,000 ft.,* 1 (KU); [near] Cedaredge, 11,000 ft., 5 (FMNH). GUNNISON COUNTY: White House Mountain, near Marble, 2 (WC); Copper Lake, 2 (USNM); *Virginia Peak, 10,900 ft.,* 2 (UMMZ); *S slope Virginia Peak, 9950 ft.,* 2 (UMMZ); *SE slope Virginia Peak,* 1 (UMMZ); *Gothic Natural Area,* 1 (UMMZ); *Sylvanite Basin, 6 mi. W Gothic,* 1 (UNM); 1 mi. W Gothic, 1 (UNM); Gothic, 5 (2 AMNH, 3 USNM); *Sylvanite Mine, Mount Gothic, 12,000 ft.,* 4 (ANSP); *Mount Gothic, 11,600 ft.,* 1 (ANSP); *Middle Brush Creek,* 2 (WC); Irwin, 10,700 ft., 2 (1 MCZ, 1 WC); Crested Butte, 2 (WC); *near Beckwith Pass,* 1 (UNM); near Round Mountain, 2 (WSC).

Additional records: JACKSON COUNTY: [near] Lake Agnes (Yeager, 1950:329). GUNNISON COUNTY: *Irwin Lake* (A. H. Howell, 1924:24).

Ochotona princeps incana A. H. Howell

Ochotona saxatilis incana A. H. Howell, Proc. Biol. Soc. Washington, 32:107, 20 May 1919; type locality, Pecos Baldy, 12,000 ft., Santa Fe Co., New Mexico.

Ochotona princeps incana, A. H. Howell, N. Amer. Fauna, 47:25, 21 August 1924.

Distribution in Colorado.—Sangre de Cristo Range, Culebra Range, and Spanish Peaks (Fig. 32).

Comparisons.—From *O. p. saxatilis,* the subspecies of the Front Range, *O. p. incana* differs in slightly paler color in winter pelage, and greater tendency to a buffy wash in summer pelage. The range of *incana* is not immediately adjacent to that of either *figginsi* or *nigrescens.* From both of the latter races, *incana* differs in markedly paler color and slightly larger average external and cranial size.

Measurements.—Mean (and extreme) external measurements of five males from the vicinity of Crestone Peak are: 199.6 (190-212), —, 34.4 (34-35), 24.0 (23-25); external measurements of a female from California Peak are: 198, —, 38, 23. For cranial measurements, see table 5.

Remarks.—A. H. Howell (1924:25) characterized *O. p. incana* as paler and less tawny in summer pelage than *O. p. saxatilis.* Specimens herein referred to *incana* from the Sangre de Cristo Range are, in fact, darker than *saxatilis* in comparable summer pelage and thus approach the color of topotypes of *figginsi.*

Howell (*loc. cit.*) suspected that *incana* ranged northward ". . . probably to Sierra Blanca, Colorado," but Warren (1942:251) did not apply the name *incana* to any Coloradan specimens. In my opinion, *incana* is the appropriate subspecific name for specimens that I have examined from the Sangre de Cristo and nearby ranges. Poncha Pass separates the ranges of *O. p. incana* and *O. p. saxatilis.*

I have no record of *O. princeps* from the Wet Mountains. In July 1970, I searched for pikas but saw no sign of them on Greenhorn Peak, the highest mountain in the range. The talus on the peak consists of fine rubble seemingly unsuitable for occupation by pikas.

Records of occurrence.—Specimens examined, 29, distributed as follows: SAGUACHE COUNTY: North Crestone Trail, 11,500 ft., 4 (WC); *Comanche Lake, near North Crestone Trail, 11,500 ft.,* 1 (WC). CUSTER COUNTY: S of Horseshoe Lake, 3 (WC). ALAMOSA COUNTY: California Peak, 2 (WC); *SW of Blanca Peak, 11,500 ft.,* 5 (CU). HUERFANO COUNTY: *Lily Lake, NW of Sierra Blanca, 12,800 ft.,* 1 (CU); West Spanish Peak, 11,900 ft., 1 (CU); *5 mi. S, 3 mi. W Cucharas Camps,* 1 (KU); 5 mi. S, 1 mi. W Cucharas Camps, 2 (KU); *head of Cucharas Creek, 11,500 ft.,* 2 (WC). LAS ANIMAS COUNTY: Trinchera Peak, 12,100 ft., 6 (CU); *S slope West Spanish Peak, 12,100 ft.,* 1 (CU).

Additional record: COSTILLA COUNTY: *[near] Fort Garland* (Coues and Yarrow, 1875:125).

Ochotona princeps saxatilis Bangs

Ochotona saxatilis Bangs, Proc. New England Zool. Club, 1:41, 5 June 1899; type locality, Montgomery, Mount Lincoln, Park Co., Colorado.

Ochotona princeps saxatilis, A. H. Howell, N. Amer. Fauna, 47:23, 21 August 1924.

Distribution in Colorado.—Front, Sawatch, and nearby ranges; San Juan Mountains (Fig. 32).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa. From *O. p. nigrescens,* the subspecies of the Jemez Mountains of New Mexico, *O. p. saxatilis* differs in larger external and cranial size and in paler, more buffy color, the pelage being markedly less heavily washed with black.

Measurements.—Mean (and extreme) external measurements of six males and five females, near topotypes from northwestern Park County, are: 191.0 (178-197), 185.6 (174-202); —; 32.0 (30-33), 32.8 (32-34); 23.3 (23-24), 23.2 (23-24). Average (and extreme) external measurements of six males and five females from the Front Range, Larimer and Boulder counties, are: 197.6 (190-202), 194.4 (180-200); —; 32.0 (32-32), 30.4 (27-32). Cranial measurements are presented in table 5.

Remarks.—Individuals of a series of specimens from southwest of Leadville (KU 113637-113648) are darker in color than is usual for *O. p. saxatilis* and are taken to be intergrades with *figginsi.* A. H. Howell (1924:24) considered specimens from Silverton to be intergrades between *saxatilis* and *nigrescens* because of their small skulls. In a majority of characters, most specimens from the western San Juans approach *saxatilis* from the Front and Sawatch ranges. Pikas from the southeastern San Juan Mountains (Navajo River drainage) in Archuleta and Conejos counties were tentatively referred by Howell (1924:26) to *nigrescens,* with the comment that they probably represented intergrades between that subspecies and *O. p. saxatilis.* Most available specimens from this critical area are housed in the Denver Museum of Natural History; skulls of these specimens evidently have been misplaced. On the basis of color alone, I judge most of the specimens to be darker than usual for *saxatilis,* but considerably paler and more buffy and grayish than *nigrescens* (as known to me only by the holotype). In the absence of associated skulls, the allocation of this material to *saxatilis* is provisional and based in part on zoogeographic considerations. Young individuals from the vicinity of Platoro are darker than is usual for *saxatilis* and lend credence to the contention of Howell that the southeastern San Juans are a zone of intermediacy.

Records of occurrence.—Specimens examined, 406, distributed as follows: LARIMER COUNTY: Crown Mountain, 2 (CSU); *1 mi. N, 33 mi. W Fort Collins, 12,200 ft.,* 1 (CSU); Trap Lake, 1 (CSU); *16 mi. NW Estes Park,* 1 (RMNP); *9 mi. NW Estes Park,* 4 (RMNP); *Fall River Pass,* 1 (RMNP); 1 mi. E Fall River Pass, 1 (RMNP); *5 mi. E Fall River Pass, 12,200 ft.,* 4 (KU); *1/2 mi. below Rock Cut Cabins, Trail Ridge Road,* 1 (RMNP); *1 mi. SE Rock Cut Cabins,* 3 (RMNP); *Willow Park,* 2 (UMMZ); *Trail Ridge Road, 12,000 ft.,* 5 (1 CU, 2 KU, 2 RMNP); *1/4 mi. W Rainbow Curve, Trail Ridge Road,* 1 (RMNP); Estes Park, 9000 ft., 5 (AMNH); Longs Peak, 5 (USNM). GRAND COUNTY: Grand Lake, 8500 ft., 1 (CU); Berthoud Pass, 7 (1 AMNH, 6 FWS); *Jones Pass,* 1 (UNM). SUMMIT COUNTY: Gore Range, 1 (DMNH); Grays Peak, 17 (2 DMNH, 3 FMNH, 12 KU); *Tenmile Creek, below Kokomo,* 9800 ft., 1 (WC); Boreas Pass, 11,470 ft., 3 (1 AMNH, 2 WC); Hoosier Pass, 11 (DMNH). BOULDER COUNTY: *Mount Meeker,* 4 (AMNH); Mount Audubon, 11,000 ft., 8 (5 CU, 3 UMMZ); Ward, 3 (2 AMNH, 1 USNM); *Science Lodge,* 2 (CU); *Niwot Ridge,* 14 (12 CU, 2 UI); *Camp Albion, 10,600 ft.,* 6 (1 CU, 5 FMNH); *Silver Lake,* 2 (1 DMNH, 1 FMNH); *Caribou,* 1 (CU); *Dixie Lake,* 1 (DMNH); Corona, 18 (1 CU, 17 FMNH); *no locality other than county,* 3 (USNM). GILPIN COUNTY: Jenny Lake, near Tolland, 2 (CU). CLEAR CREEK COUNTY: *Berthoud Pass,* 2 (KU); Silverplume, 11,000 ft., 1 (DMNH); Loveland Pass, 21 (2 CU, 1 FWS, 18 DMNH); *Mount Kelso, 12,000 ft.,* 1 (USNM); *Summit Lake, Mount Evans, 12,000 ft.,* 1 (CU); Mount Evans, 13,000 ft., 16 (5 CSU, 10 DMNH, 1 FMNH); *Ptarmigan Peak, 12,500 ft.,* 1 (CU). PITKIN COUNTY: Aspen, 1 (DMNH); *Hunters Creek, near Aspen,* 1 (DMNH); Ivanhoe, 2 (SC). LAKE COUNTY: 11 mi. SW Leadville, 12,000 ft., 7 (KU); *13 mi. SW Leadville, 12,000 ft.,* 5 (KU); Twin Lakes, 3 (USNM). PARK COUNTY: Geneva Park, 5 (AMNH); *8 mi. NNW Grant, 10,000 ft.,* 3 (FWS); *Call [Hall?] Valley, 10 mi. W Webster,* 4 (DMNH); Webster, 6 (DMNH); *Mount Lincoln,* 4 (MCZ); *S slope Mount Lincoln, 12,500 ft.,* 8 (3 USNM, 5 WC); *Mount Bross,* 3 (DMNH); Montgomery, 30 (MCZ); *Buckskin Creek, 3 mi. above Alma,* 11,000 ft., 5 (2 USNM, 3 WC); *Buckskin Ridge, Alma, 12,000 ft.,* 4 (1 USNM, 3 WC); *Kite Lake, above Alma,* 2 (DMNH); *Mount Loveland, near Alma,* 1 (DMNH); *Alma,* 2 (DMNH); Fairplay, 1 (AMNH). GUNNISON COUNTY: Tincup, 4 (DMNH). CHAFFEE COUNTY: 12 mi. W Buena Vista, 1 (UMMZ); Buena Vista, 1 (UMMZ); *"high peak above Cottonwood,"* 2 (WC); Mount Shavano, 11,000 ft., 3 (WC); Monarch, 10,700 ft., 1 (MCZ); *Monarch Park, 10,728 ft.,* 1 (WC). TELLER COUNTY: Glen Cove, 5 (UMMZ). EL PASO COUNTY: Crater, Pikes Peak, 12,000 ft., 1 (UMMZ); *above Windy Point, Pikes Peak, 12,500 ft.,* 3 (WC); *Windy Point, 12,000 ft.,* 2 (WC). OURAY COUNTY: 12 mi. S Ouray, 1 (SC); *Red Mountain,* 1 (AMNH); *near Red Mountain, 12,000 ft.,* 1 (WC); Red Mountain Pass, 3 (SC). SAN MIGUEL COUNTY: Lone Cone Peak, 3 (SC). SAGUACHE COUNTY: Cochetopa Dome, 26 mi. SE Gunnison, 9500 ft., 2 (CSU); *27 mi. SE Gunnison,* 1 (FHSC); Baldy Chato, 27 mi. SE Gunnison, 12,000 ft., 1 (CSU). DOLORES COUNTY: Mount Wilson, 4 (SC); W side Wilson Peak, 2 (MCZ). SAN JUAN COUNTY: 9 mi. NE Silverton, 1 (USNM); *Eureka,* 4 (UNM); Silverton, 16 (USNM); Molas Divide, 7 (DMNH). HINSDALE COUNTY: Crystal Lake, 5 mi. W Lake City, 2 (USNM). MINERAL COUNTY: West Willow Creek, 7 mi. above Creede, 1 (WC); Commodore Mine, Creede, 1 (WC); near Wolf Creek Pass, 10,800 ft., 3 (WC); *1/2 mi. N Alberta Park, 11,200 ft.,* 3 (CSU). RIO GRANDE COUNTY: Del Norte Peak, 2 (UMMZ); Old Baldy Mountain, 12,600 ft., 1 (ASC). LA PLATA COUNTY: Lime Creek, 39 7/10 mi. N Durango, 4 (WSC); 8 mi. N, 2 mi. W Hesperus, 1 (UI). ARCHULETA COUNTY: Horse Spring Mountain, near Dyke, 1 (DMNH); Upper Navajo River, 6 (DMNH); Navajo Peaks, 9 (DMNH). CONEJOS COUNTY: Platoro, 2 (FHSC); *"2-3 mi. E Platoro,"* 1 (FHSC); *1 mi. SW Platoro,* 1 (FHSC); *"3-5 mi. SW Platoro,"* 1 (FHSC); near La Manga Pass, 11,500 ft., 2 (WC); *Cumbres,* 6 (2 CU, 3 USNM, 1 WC); Osier, 4 (DMNH).

Additional records: GRAND COUNTY: *Milner Pass* (Dixon, 1931:72). BOULDER COUNTY: *Bald Mountain, near Ward* (A. H. Howell, 1924:24). CLEAR CREEK COUNTY: *Argentine Pass* (Coues and Yarrow, 1875:125). PARK COUNTY: Geneva Park (J. A. Allen, 1912:103); *NE slope Mount Lincoln* (J. A. Allen, 1872:160); *Cameron Amphitheater, Mount Lincoln* (Blake and Blake, 1969:35). CONEJOS COUNTY: *Cumbres Pass* (W. S. Long, 1938:150).

Family Leporidae—Rabbits and Hares

Sylvilagus floridanus

Eastern Cottontail

The eastern cottontail is an abundant mammal throughout eastern United States and Mexico, extending westward to the Rocky Mountains in suitable habitat. In Colorado the species is rather strictly confined to riparian communities along the major streams of the eastern plains. Over its range in Colorado, *Sylvilagus floridanus* is sympatric with *Sylvilagus audubonii,* but the species are segregated locally by different habitat preferences. The much darker color of the eastern cottontail readily distinguishes it from *S. au-*

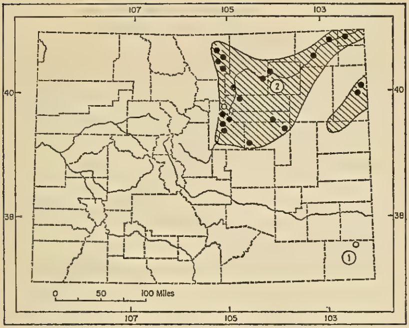


Fig. 33. Distribution of *Sylvilagus floridanus* in Colorado. 1. *S. f. llanensis.* 2. *S. f. similis.* For explanation of symbols, see p. 9.

dubonii in the field. From *Sylvilagus nuttallii*, external differences are more subtle, but differences in preferred habitat are practically absolute in the limited zone in which the ranges of the two kinds approach one another.

The three species of cottontails are important small game animals in Colorado. According to unpublished data compiled by the Division of Game, Fish and Parks for the years 1955 through 1968, the annual number of hunters pursuing cottontails ranged from about 36,000 up to about 64,000. Annual harvest ranged from about 136,000 (including snowshoe hare) in 1962 to some 385,000 (cottontails only) in 1958. Average season bag ranged from a low of 3.8 animals per hunter in 1962 and 1965 (including snowshoe hare) to a high of 7.4 animals per hunter (cottontails only) in 1968.

Sylvilagus floridanus llanensis Blair

Sylvilagus floridanus llanensis Blair, Occas. Papers, Mus. Zool. Univ. Michigan, 380:1, 21 June 1938; type locality, Old "F" Ranch Headquarters, Quitaque, Briscoe Co., Texas.

Distribution in Colorado.—Presently known only from Baca County (Fig. 33); to be expected locally south of Arkansas River in southeastern quarter of state.

Comparison.—From *S. f. similis*, the subspecies of the South Platte drainage, *S. f. llanensis* differs in more reddish dorsal color; "ears longer, more rusty outside; sides more brownish; hind toes and feet more Rufous above; underside of neck more buffy" (Blair, 1938:1); winter pelage darker, more reddish.

Measurements.—Cockrum (1952:104) presented external and cranial measurements of two males and a female from southwestern Kansas as follows: 385, 405, 430; 50, 50, —; 95, 95, 101; 53, 60, 58. Mean (and extreme) cranial measurements of four males and cranial measurements of two females, all from southwestern Kansas, are (*op. cit.*:109): basilar length, 53.9 (53.3-54.6), 55.4, 57.6; zygomatic breadth, 34.8 (34.5-35.2), 38.3, 37.2; postorbital constriction, 12.4 (11.2-13.9), 13.8, 12.3; length of maxillary toothrow, 14.0 (13.5-14.4), 15.3, 15.5; least length of palatal bridge, 6.3 (6.0-6.9), 6.1, 6.8; length of nasals, 30.9 (30.2-31.9), 30.8, 32.8.

Records of occurrence.—Specimens examined, 1, as follows: BACA COUNTY: Two Buttes, 1 (DMNH).

Sylvilagus floridanus similis Nelson

Sylvilagus floridanus similis Nelson, Proc. Biol. Soc. Washington, 20:82, 22 July 1907; type locality, Valentine, Cherry Co., Nebraska.

Distribution in Colorado.—In suitable habitat in northeastern quarter of state (Fig. 33).

Comparison.—For comparison with *S. f. llanensis*, see account of that subspecies.

Measurements. — No coherent series of adults of this subspecies is available from Colorado. Jones (1964:107) gave mean (and extreme) external measurements of 10 individuals (a male and nine females) from Cherry County, Nebraska, as follows: 420.3 (400-452); 50.5 (41-71); 97.5 (83-104); 55.9 (52-61). Average (and extreme) cranial measurements of six individuals (a male and five females) from Cherry County include (*op. cit.*:115): greatest length of skull, 72.6 (70.8-75.3); zygomatic breadth, 36.0 (35.6-36.4); postorbital constriction, 12.5 (11.4-14.8); length of incisive foramen, 18.2 (16.6-19.2); length of maxillary toothrow, 15.0 (14.3-15.8); least length of palatal bridge, 6.5 (5.9-6.9). For additional measurements, see Cockrum (1952:103, 109).

Records of occurrence.—Specimens examined, 47, distributed as follows: LARIMER COUNTY: 17 mi. NW Fort Collins, 1 (CSU); *8 mi. NNW Fort Collins*, 1 (CSU); *9 mi. NW Fort Collins*, 1 (CU); *sec. 21*, *T. 9 N, R. 69 W,* 1 (CSU); *1 mi. E Bellvue,* 1 (CSU); *4 mi. N Fort Collins,* 1 (CSU); *4 mi. NW Fort Collins,* 1 (CSU); 5 mi. W Fort Collins, 1 (CSU); *Horsetooth Reservoir,* 2 (CSU); *Fort Collins,* 1 (DMNH); *2 mi. W Dixon Dam,* 1 (CSU); *1 mi. S, 4 mi. W Fort Collins,* 1 (CSU); *1 1/2 mi. W Timnath,* 1 (CSU); *5 1/2 mi. SW Fort Collins,* 1 (CSU); 8 mi. SW Fort Collins, 1 (CSU); Loveland, 1 (CU). WELD COUNTY: Masters, 1 (USNM); 1/2 mi. S, 2 mi. W Platteville, 2 (1 CSU, 1 CU); *no locality other than county,* 1 (DMNH). MORGAN COUNTY: Orchard, 1 (WC). LOGAN COUNTY: Crook, 1 (DMNH); Sterling, 1 (USNM). SEDGWICK COUNTY: Sedgwick, 1 (DMNH). JEFFERSON COUNTY: Deer Creek, 1 (MCZ); *North Fork, South Platte River,* 1 (MCZ); *Twin Creeks [Twin Forks],* 1 (MCZ); Bear Creek, 1 (MCZ). ADAMS COUNTY: Barr, 1 (WC); *Griswold Ranch* (not found), 1 (DMNH). ARAPAHOE COUNTY: Deer Trail, 1 (AMNH); near Littleton, 2 (WC); *Plum Creek, near Littleton,* 1 (WC). YUMA COUNTY: near Wray, 3 (DMNH); Dry Willow Creek, 2 (CU); *no locality other than county,* 1 (DMNH). DOUGLAS COUNTY: "in woods along Platte River," 1 (DMNH). ELBERT COUNTY: 6 1/2 mi. N Riverbend, 2 (CU); 3 mi. S Elbert, 3 (CU).

Additional record: JEFFERSON COUNTY: Arvada (Nelson, 1909:172).

Sylvilagus nuttallii

NUTTALL'S COTTONTAIL

Sylvilagus nuttallii occurs over much of the western United States. In Colorado, it characteristically inhabits edge situations in forests at moderate elevations. In the northwestern part of the state and in the San Luis Valley, treeless areas are occupied, but typically only where a cover of brush is well developed. Seldom are areas utilized as open as those favored by *Sylvilagus audubonii.* According to Warren (1942:271), the altitudinal range of Nuttall's cottontail is from about 6000 to 11,500 feet in the Pikes Peak area.

Sylvilagus nuttallii and *S. floridanus* generally are allopatric. Along the Front Range, the distributions of the two species interdigitate due to ecological complexity of certain sites. Along Rist Canyon, west of Bellvue, for example, one can observe three species of cottontails within a few yards of each other. *Sylvilagus nuttallii* occupies the edge of the coniferous woodland, *S. floridanus* occupies the community of phreatophytic brush along the stream, and *S. audubonii* occurs in the open, xeric band of short-grass and shrubs between them. A similar pattern is repeated locally along the mountain front southward into Jefferson and Douglas counties. Despite the close proximity of the ranges of *S. nuttallii* and *S. floridanus,* there apparently is no hybridization between the two species. A detailed ecological study of the three species of *Sylvilagus* in this zone of parapatry would be of considerable interest.

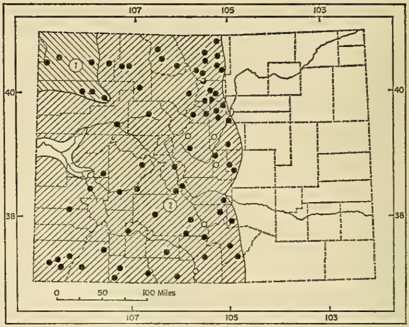


FIG. 34. Distribution of *Sylvilagus nuttallii* in Colorado. 1. *S. n. grangeri.* 2. *S. n. pinetis.* For explanation of symbols, see p. 9.

Sylvilagus nuttallii grangeri (J. A. Allen)

Lepus sylvaticus grangeri J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:264, 21 August 1895; type locality, Hill City, Pennington Co., South Dakota.

Sylvilagus nuttalli [sic] grangeri, Nelson, N. Amer. Fauna, 29:204, 31 August 1909.

Distribution in Colorado.—Lower valleys of White and Yampa rivers, northwestern part of state (Fig. 34).

Comparison.—From *S. n. pinetis,* the subspecies to the east and south in Colorado, *S. n. grangeri* differs in paler color (more yellowish buff, less pinkish buff, and less heavily overlaid with black), and slightly smaller average external and cranial size.

Measurements.—External measurements of females from Moffat and Rio Blanco counties are: 385, 381; 32, 38; 102, 95. Selected cranial measurements are presented in table 6.

Remarks.—Long (1965:543) was of the opinion that Nuttall's cottontails from Wyoming all were referable to a single subspecies, and noted that there was no indication of

TABLE 6

Selected cranial measurements of two species of *Sylvilagus*.

Number averaged (or catalog number), sex	Greatest length of skull	Zygomatic breadth	Postorbital breadth	Length of incisive foramen	Least length of palatal bridge	Length of nasals	Length of maxillary toothrow
Sylvilagus nuttallii grangeri, Dinosaur National Monument, Moffat County							
CU 4738, ♀	67.0	35.0	11.6	17.0	6.0	28.8	12.9
Meeker, Rio Blanco County							
WC 461, ♀	65.5	34.3	11.6	15.9	6.1	31.3	12.9
Sylvilagus nuttallii pinetis, Crawford, Delta County							
WC 22, ♂	69.2	35.0	11.0	17.4	5.8	31.1	12.9
WC 24, ♂	67.7	34.9	10.8	17.3	5.8	29.8	12.6
WC 25, ♂	72.6	34.5	11.3	17.8	6.8	——	13.0
WC 23, ♀	72.4	35.7	12.0	19.6	5.6	32.2	13.3
Glenwood Springs, Garfield County							
WC 478, ♂	——	34.6	11.6	15.9	6.1	29.6	12.8
WC 476, ♀	70.2	——	10.8	17.3	5.6	30.9	12.6
Sylvilagus audubonii baileyi, Larimer County							
CSU 12097, ♂	72.3	34.8	10.9	18.1	5.1	31.6	13.5
CSU 12531, ♂	68.6	34.6	10.5	17.1	5.7	29.8	12.5
Mean, 9 ♀	69.99	35.23	10.77	17.61	5.62	29.87	13.42
Minimum	67.9	33.3	8.9	16.2	5.2	27.8	12.7
Maximum	74.1	36.5	11.7	18.9	5.9	31.2	13.8
Baca County							
Mean, 5 ♂	69.64	34.86	11.62	17.74	5.64	30.54	13.04
Minimum	68.4	34.4	10.7	17.3	5.1	28.6	12.8
Maximum	71.0	35.5	12.2	18.0	6.2	31.8	13.3
WC 668, ♀	69.5	34.9	11.2	18.3	5.7	30.9	12.3
Sylvilagus audubonii warreni, Montrose and Montezuma counties							
Mean, 5 ♂	66.78	33.70	11.46	16.64	5.52	29.36	12.12
Minimum	64.5	33.0	10.5	16.1	4.8	28.0	12.0
Maximum	69.1	34.4	12.5	18.0	5.9	31.8	12.4
WC 1392, ♀	65.8	35.7	11.8	15.6	5.8	26.8	12.1
WC 1780, ♀	65.9	35.2	10.9	15.7	5.4	27.8	12.5

intergradation between *S. n. grangeri* and *S. n. pinetis* in southern Wyoming, statements of Nelson (1909:543) notwithstanding.

In Colorado it is apparent that recognition of two subspecies is justified. Over large areas of the mountainous western three-fifths of the state, *S. nuttallii* is the only cottontail to be found. These animals represent a richly colored race. In the northwestern part of the state, in the lower valleys of the White and Yampa rivers, *S. audubonii* is grossly sympatric with *S. nuttallii.* Character convergence occurs in the zone of sympatry. Individuals of *S. nuttallii* tend to be pale in color and are generally distinct from populations at higher elevations to the south and east. Superficially these animals look much like representatives of *S. audubonii warreni,* although obvious cranial differences between the populations are, of course, maintained. I agree with Nelson (1909) in applying the name *grangeri* to the pale-colored race of Nuttall's cottontail of the shrublands of northwestern Colorado. The more richly colored animals over the remainder of the range of the species in Colorado are referred herein to *S. n. pine-*

tis. Convergence is not apparent between *nuttallii* and *audubonii* in southwestern Colorado, or along the Front Range.

Records of occurrence.—Specimens examined, 14, distributed as follows: MOFFAT COUNTY: Escalante Hills, 20 mi. SE Ladore, 1 (USNM); *Douglas Spring,* 1 (WC); mouth of Hell's Canyon, Dinosaur National Monument, 1 (CU); *The Birches, Dinosaur National Monument,* 1 (CU); Lay, 2 (USNM). RIO BLANCA COUNTY: White River, 6000 ft., 1 (AMNH); Meeker, 1 (WC); *Dry Fork, White River, 6200 ft.,* 5 (AMNH); Dry Fork, White River, 6300 ft., 1 (AMNH).

Sylvilagus nuttallii pinetis (J. A. Allen)

Lepus sylvaticus pinetis J. A. Allen, Bull. Amer. Mus. Nat. Hist., 6:348, 7 December 1894; type locality, White Mountains, S of Mt. Ord, Apache Co., Arizona (see Warren, 1942:270).

Sylvilagus nuttalli [sic] pinetis, Nelson, N. Amer. Fauna, 29:207, 31 August 1909.

Distribution in Colorado.—Suitable habitat of mountains, mesas, plateaus, and high valleys of western three-fifths of state, except northwest corner (Fig. 34).

Comparison.—For comparison with *S. n. grangeri,* see account of that subspecies.

Measurements.—External measurements of three males and a female from Crawford, Delta County, are: 389, 384, 409, 398; 32, 53, 51, 43; 90, 93, 104, 97; 58, 63, 61, 57 (dry). External measurements of three females from near Yampa, Routt County, are: 393, 378, 396; 41, 38, 50; 93, 100, 98; 62, 58, 60 (dry); weights, 2 1/2, —, 2 pounds. Mean (and extreme) external measurements of four males, followed by measurements of two females, all from Glenwood Springs, Garfield County, are: 377.0 (367-397), 388, 383; 40.2 (36-43), 34, 41; 97.2 (90-104), 101, 97; 64.0 (60-68), 62, 67 (dry). For representative cranial measurements, see table 6.

Remarks.—R. T. Young (1908:404) noted that he had captured *S. n. pinetis* ". . . 12 km. east of Boulder on the hot barren plains." In the absence of a specimen from that vicinity, or any locality on the Eastern Slope of the character described, I am inclined to doubt the record.

Records of occurrence.—Specimens examined, 145, distributed as follows: MOFFAT COUNTY: Craig, 1 (WC); *Fortification Creek, near Craig,* 1 (WC). ROUTT COUNTY: near Hayden, 2 (DMNH); 6 mi. E Hayden, 1 (WC); *5 mi. below Hayden, 6300 ft.,* 1 (WC); Yampa, 2 (WC); *near Yampa,* 2 (WC). JACKSON COUNTY: Boettcher Ranch, Lake John, 1 (DMNH); Hebron, 2 (USNM); Homestead Ranch, 1 (DMNH); *no locality other than county,* 4 (DMNH). LARIMER COUNTY: 15 mi. E Virginia Dale, 1 (CU); 1 1/2 mi. NE Rustic, 8500 ft., 1 (CSU); *10 mi. N, 20 mi. W Fort Collins,* 1 (CU); 5 1/4 mi. N, 5 3/4 mi. W Fort Collins, 1 (CSU); *5 mi. NW Fort Collins,* 2 (CU); sec. 15, T. 7 N, R. 73 W, 1 (CU); 11 mi. SW Fort Collins, 1 (CSU); *Arkins,* 1 (USNM); 1 mi. N, 2 1/2 mi. W Loveland, 1 (CSC); Trail Ridge Road, 1 (RMNP); *E of Deer Ridge,* 1 (RMNP); Estes Park, 5 (1 AMNH, 4 USNM); *East District Office,* 1 (RMNP); *N of Moraine Park Visitor's Center,* 1 (RMNP); *Moraine Park Visitor's Center,* 1 (RMNP); *4 mi. S, 2 mi. W Estes Park,* 1 (KU); Longs Peak, 1 (USNM). GARFIELD COUNTY: Glenwood Springs, 9 (1 AMNH, 1 MCZ, 7 WC). EAGLE COUNTY: Wolcott, 1 (USNM); *3 mi. below Wolcott, 6900 ft.,* 1 (WC). GRAND COUNTY: Coulter, 1 (USNM); *no locality other than county,* 2 (DMNH). BOULDER COUNTY: *Mount Meeker,* 1 (AMNH); Gold Hill, 8000 ft., 1 (USNM); *NW of Boulder,* 1 (CU); *8 mi. WSW Boulder, 7500 ft.,* 1 (KU); Boulder, 4 (2 FMNH, 2 USNM); Pinecliff, 8500 ft., 1 (DMNH). CLEAR CREEK COUNTY: Clear Creek, 1 (FWS); Evans Ranch, Brookvale, 4 (DMNH). JEFFERSON COUNTY: Arvada, 1 (CU); Golden, 1 (USNM); *Morrison,* 3 (1 DMNH, 2 KU); above Evergreen, 2 (FWS). ARAPAHOE COUNTY: Littleton, 2 (DMNH). PARK COUNTY: South Park, 2 (DMNH). DOUGLAS COUNTY: 41 mi. S, 6 mi. W Denver, 1 (CU). DELTA COUNTY: near Crawford, 5 (WC). GUNNISON COUNTY: 3 mi. W Crested Butte, 1 (WC); 1 mi. S Gunnison, 1 (WSC); Sapinero, 2 (USNM). CHAFFEE COUNTY: Buena Vista, 3 (UMMZ); Salida, 4 (1 WC, 3 USNM); 1 mi. below Poncha Pass, 1 (WC); *no locality other than county,* 1 (DMNH). TELLER COUNTY: 14 mi. N Florissant, 8900 ft., 1 (FWS); *10 mi. N Florissant, 8900 ft.,* 1 (FWS); *9 mi. N Florissant, 8900 ft.,* 1 (FWS). EL PASO COUNTY: 3 mi. NE Manitou, 1 (WC); Colorado Springs, 1 (FMNH); Lake Moraine, 1 (MCZ); *near Lake Moraine,* 1 (WC). MONTROSE COUNTY: Montrose, 1 (DMNH); Coventry, 1 (WC). SAGUACHE COUNTY: 4 mi. N, 20 mi. W Saguache, 1 (KU); 8 mi. E Moffat, 4 (UI); 5 mi. NW Hooper, 1 (DMNH). FREMONT COUNTY: Greenhorn Mountains, 1 (FMNH); *no locality other than county,* 2 (1 DMNH, 1 FMNH). CUSTER COUNTY: no locality other than county, 1 (DMNH). PUEBLO COUNTY: no locality other than county, 3 (DMNH). MINERAL COUNTY: Santa Maria Lake, 1 (USNM). RIO GRANDE COUNTY: 8 mi. S, 11 mi. W Monte Vista, 1 (UI). ALAMOSA COUNTY: 24 mi. E Hooper, 2 (DMNH). HUERFANO COUNTY: 8 mi. W Walsenburg, 1 (DMNH); Spanish Peaks, 1 (DMNH). MONTEZUMA COUNTY: Mancos, 2 (1 AMNH, 1 WC); 3/4 mi. S, 1 3/4 mi. W Park Point, Mesa Verde National Park, 1 (KU); 1 3/4 mi. N Park Headquarters, Mesa Verde National Park, 1 (KU); Ute Peak, 1

(DMNH). LA PLATA COUNTY: 21 mi. N Bayfield, 1 (AMNH); Fort Lewis, 1 (WC); *East Animas* (not found), 1 (WSC). ARCHULETA COUNTY: Deep Cañon, 2 (UNM); Navajo River, 3 (DMNH); sec. 18, T. 32 N, R. 4 W, 1 (UNM). CONEJOS COUNTY: Conejos River, 8250 ft., 1 (USNM); *Conejos River, 8600 ft.*, 1 (USNM). COSTILLA COUNTY: Mount Baldy, near Fort Garland, 3 (1 MCZ, 2 USNM).

Additional records: JEFFERSON COUNTY: Buffalo Creek P. O. (Nelson, 1909:210). PARK COUNTY: *northwestern South Park* (J. A. Allen, 1874:58); *Mount Lincoln* (Blake and Blake, 1969: 35). GUNNISON COUNTY (Durrant and Robinson, 1962:243): *Dry Gulch, 3/4 mi. above Gunnison River, 7470 ft.; Dry Gulch at Gunnison River; Cebolla Creek.* TELLER COUNTY: Florissant (Nelson, *loc. cit.*). EL PASO COUNTY: *Dead Lake Divide* (Nelson, *loc. cit.*). SAGUACHE COUNTY: Medano Pass (Nelson, *loc. cit.*). MONTEZUMA COUNTY: *Wetherill Mesa, 2 mi. NNW Rock Springs, 7900 ft., Mesa Verde National Park* (Anderson, 1961:40). CONEJOS COUNTY: Rio Grande (Coues and Yarrow, 1875: 128). COSTILLA COUNTY: *Fort Garland* (Coues and Yarrow, *loc. cit.*).

Sylvilagus audubonii

Desert Cottontail

The desert cottontail occurs throughout much of semiarid western North America. In Colorado, *Sylvilagus audubonii* is found statewide at elevations below about 6500 to 7000 feet. The highest elevations from which specimens were examined are about 7500 feet in the Arkansas River Valley, and various points in the San Luis Valley at about 7700 feet. Preferred habitat of the desert cottontail in western Colorado is brushlands and woodland-edge situations in canyons, in valleys, or on mesas. In the east, similar habitats are utilized where available, but the species also occurs in more open country where cover may be minimal. Abandoned burrows of badgers, prairie dogs, or even pocket gophers (Vaughan, 1961) may be utilized.

Dice (1929) described attempts to breed Coloradan cottontails in captivity. Duszynski and Marquardt (1969) reported on coccidian parasites (Eimeriidae) in *S. audubonii* in Larimer County.

Nelson (1909) revised the subspecies of *S. audubonii.* With minor qualifications, that revision is followed in the accounts of subspecies below. Hoffmeister and Lee (1963) revised southwestern races of the desert cottontail.

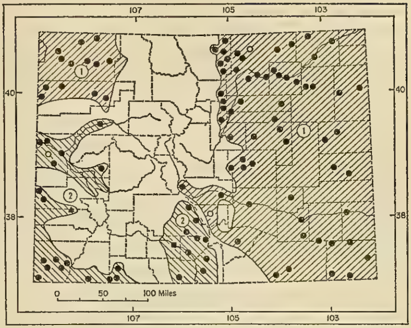


FIG. 35. Distribution of *Sylvilagus audubonii* in Colorado. 1. *S. a. baileyi.* 2. *S. a. warreni.* For explanation of symbols, see p. 9.

Sylvilagus audubonii baileyi (Merriam)

Lepus baileyi Merriam, Proc. Biol. Soc. Washington, 11:148, 9 June 1897; type locality, Spring Creek, E side Bighorn Basin, Washakie Co., Wyoming (*fide* Long, 1965:544).

Sylvilagus audubonii baileyi, Lantz, Trans. Kansas Acad. Sci., 22:336, 1908.

Distribution in Colorado.—Semiarid plains of eastern two-fifths of state; northwestern Colorado, north of Roan Plateau (Fig. 35).

Comparisons. — From *S. a. warreni,* the subspecies of southwestern Colorado, *S. a. baileyi* differs in generally paler color, less pronouncedly reddish nape, and less well-defined gray patch on rump. From *S. a. neomexicanus,* the subspecies of northern New Mexico, *S. a. baileyi* differs in markedly paler, more buffy color, without prominent rusty wash on dorsum, sides, and feet.

Measurements.—External measurements of two males, followed by mean (and extreme) external measurements of nine females, from Larimer County, are: 431, 448, 410.5 (392-438); 44, 46, 46.8 (35-56); 86, 98, 89.9 (83-100); 65, 75, 69.7 (59-88); weight, 1124, 985, 952.0 (609-1139). Mean (and extreme) external measurements of five males, followed by measurements of a female, all from Baca County (intergrades with *neomexicanus*), are: 395.8 (390-410), 403; 52.0 (38-65), 41; 92.4 (86-96), 94; 59.8 (56-63), 58 (dry). Selected cranial measurements are presented in table 6.

Remarks.—Cockrum (1952:107) referred specimens of S. *audubonii* from southwestern Kansas to the subspecies *neomexicanus.* A specimen from Monon, Baca County, Colorado (WC 670, a male), approaches the color and markings of *neomexicanus,* as does a specimen from 10 mi. SW of Tobe, Las Animas County (KU 68448, a male). Specimens from other localities in Baca County are slightly darker and somewhat more reddish than specimens of *baileyi* from farther north. Specimens from along the Arkansas River (Pueblo, La Junta, Lamar) are clearly referable to *baileyi* as understood by me. All desert cottontails from eastern Colorado are herein referred to the subspecies *S. a. baileyi;* that subspecies apparently intergrades with *neomexicanus* in a broad zone in the Raton Section and the Cimarron River drainage.

Records of occurrence.—Specimens examined, 265, distributed as follows: MOFFAT COUNTY: [Little] Snake River, 20 mi. W Baggs, 1 (USNM); [Little] Snake River, S of Sunny Peak, 2 (USNM); *[Little] Snake River,* 1 (AMNH); Two Bar Spring, 2 (DMNH); Douglas Spring, 3 (WC); *Lone Mountain, 5 mi. W [Little] Snake River,* 6000 ft., 4 (WC); *Sand Creek, near Bear [Yampa] River, 5850 ft.,* 2 (1 AMNH, 1 WC); *mouth of Sand Creek,* 1 (WC); N side Bear [Yampa] River, opposite Maybell, 1 (WC); Fortification Creek, near Craig, 1 (WC); Lay, 6 (2 AMNH, 3 USNM, 1 WC); *Lower Bridge, [Little] Snake River,* 1 (WC); between [Little] Snake River bridge and Lily, 1 (WC); *no locality other than county,* 1 (DMNH). LARIMER COUNTY: *37 mi. N Fort Collins, 5 mi. W Interstate 25, 5000 ft.,* 1 (CSU); 17 mi. N Wellington, 4 (CU); 18 mi. NW Fort Collins, 1 (CSU); *17 mi. NW Fort Collins,* 1 (CU); *Poudre Park,* 1 (CSU); *3 mi. N Waverly,* 1 (CU); *sec. 21, T. 9 N, R. 69 W,* 1 (CSU); 3 mi. NW Wellington, 1 (CSU); *12 mi. NW Fort Collins,* 1 (CSU); *10 mi. NE Fort Collins,* 1 (CSU); *7 mi. N Fort Collins,* 1 (CSU); *1 1/2 mi. W Ted's Place,* 1 (CU); *8 1/2 mi. NE Fort Collins,* 1 (CSU); *2 mi. NE La Porte, 5200 ft.,* 1 (CSU); *4 mi. NW Fort Collins,* 1 (CU); *2 3/10 mi. N, 4 2/10 mi. W Fort Collins,* 1 (CU); *2 1/10 mi. N, 4 3/10 mi. W Fort Collins, 5400 ft.,* 1 (CU); *Terry Lake,* 1 (CSU); *5 mi. NW Fort Collins,* 2 (CU); *1 mi. N, 4 mi. W Fort Collins,* 1 (CU); *1 mi. N, 4 mi. E Fort Collins,* 1 (CU); *4 mi. W Fort Collins,* 2 (1 CSU, 1 CU); *3 mi. W Fort Collins, 5500 ft.,* 2 (1 CSU, 1 CU); *1 mi. W Fort Collins,* 2 (1 CSU, 1 CU); *Fort Collins,* 2 (1 CSU, 1 DMNH); 1 mi. E Fort Collins, 1 (CU); *3 1/2 mi. E Fort Collins,* 1 (CSU); *1 mi. S, 4 mi. W Fort Collins,* 1 (CU); *1 mi. S, 1 mi. W Fort Collins,* 1 (CSU); *1/4 mi. E Horsetooth Reservoir,* 1 (CSU); *sec. 18, T. 7 N, R. 69 W, 5200 ft.,* 2 (CSU); *2 mi. S, 1 mi. W Fort Collins,* 1 (CU); *3 mi. SW Fort Collins,* 1 (CSU); *1/4 mi. S, 1/4 mi. E Dixon Dam,* 1 (CU); *3 mi. S, 1 1/2 mi. W Fort Collins,* 1 (CU); *5 mi. SW Fort Collins,* 1 (CU); *3 mi. S Fort Collins,* 2 (CSU); *Horsetooth Mountain, 6000 ft.,* 1 (CU); *4 mi. S, 2 mi. E Fort Collins,* 1 (CU); *7 1/2 mi. SE Fort Collins,* 1 (CU); *8 mi. SW Fort Collins,* 2 (CU); *6 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *12 mi. S, 1 mi. W Fort Collins, 5200 ft.,* 1 (CSU); Loveland, 8 (USNM); *no locality other than county,* 1 (CSU). WELD COUNTY: Avalo, 3 (USNM); 12 mi. NW New Raymer, 2 (CU); Nunn, 1 (DMNH); *6 mi. E Pierce,* 1 (CSU); 3 mi. N, 19 mi. E Fort Collins, 1 (CSU); *7 mi. N, 3 mi. W Galeton,* 1 (UNM); 3 mi. S Windsor, 1 (CSU); 6 mi. E Kersey, 1 (CSC); 1 mi. W Hardin, 2 (CU); *3 mi. S, 7 mi. E Kersey,* 1 (CSC); 28 mi. W Fort Morgan, 3 (UMMZ); 3 mi. S, 7 mi. E La Salle, 1 (CSC). MORGAN COUNTY: Jackson Reservoir, 5 (DMNH); Weldona, 1 (DMNH); Fort Morgan, 6 (UMMZ); 5 mi. S Brush, 1 (KU); *5 mi. S, 3 mi. E Wiggins, 4300 ft.,* 1 (CSU). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU); *Chimney Cañon, 10 mi. NE Avalo,* 1 (USNM); Crook, 2 (1 AMNH, 1 DMNH); Sterling, 1 (USNM). RIO BLANCO COUNTY: 5 mi. W Rangely, 1 (USNM); *Rangely,* 4 (DMNH); White River, 20 mi. E Rangely, 1 (USNM); Meeker, 1 (USNM); *3 mi. below White Rock, above Meeker,* 1 (WC); *2 mi. below White Rock, above Meeker,* 1 (WC); 20 mi. SW Rangely, 1 (USNM); *Dry Fork, White River, 6200 ft.,* 4 (AMNH); Dry Fork, White River, 6500 ft., 2 (AMNH). BOULDER COUNTY: Whiterock, 1 (CU); *prairie E of Bear Canyon,* 1 (CU); Broomfield, 1 (FWS). JEFFERSON COUNTY: Semper, 5 (USNM); *Eleanor,* 1 (DMNH); *Wheatridge,* 1 (DMNH); *Denver Federal Center,* 1 (FWS); Evergreen, 1 (DMNH). ADAMS COUNTY: Barr, 3 (DMNH); Leader, 1 (UMMZ); *no locality other than county,* 1 (KU). DENVER COUNTY: Denver, 1 (DMNH). ARAPAHOE COUNTY: Deer Trail, 6 (DMNH). WASHINGTON COUNTY: 10 mi. W Akron, 2 (UMMZ); Akron, 1 (UMMZ). YUMA COUNTY: Wray, 9 (8 DMNH, 1 USNM); *near Wray,* 4 (DMNH); *28 mi. NW St. Francis, Kansas,* 1 (KU); 6 mi. S Yuma, 1 (CSU). DOUGLAS COUNTY: 10 mi. SW Castle Rock, 1 (UMMZ). ELBERT COUNTY: Agate, 1 (DMNH); Kiowa, 1 (DMNH); 8 mi. N Riverbend, 1 (CU). KIT CARSON COUNTY: 15 mi. NE Seibert, 1 (USNM); Flagler, 1 (USNM); *1/2 mi. E Flagler,* 1 (CSU). CHAFFEE COUNTY: Salida, 7572 ft., 3 (WC). EL PASO COUNTY: 18 mi. NE Colorado Springs, 1 (UMMZ); 3 mi. NE Falcon, 1 (UMMZ); *6 mi. N Colorado Springs,* 1 (UMMZ); *3 mi. N Colorado Springs,* 2 (WC); *2 mi. NE Colorado Springs,* 1 (WC); *Colorado Springs,* 3 (2 AMNH, 1 WC); *15 mi. E Colorado Springs,* 1 (WC); Minnehaha, 1 (UMMZ). CHEYENNE COUNTY: 3 mi. SW Sorrento, 1 (FWS); 10 mi. S Firstview, 1 (CU). FREMONT COUNTY: Rockvale, 7 (FMNH). PUEBLO COUNTY: Pueblo, 1 (USNM). CROWLEY COUNTY: 20 mi. N Ordway, 1 (FWS). HUERFANO COUNTY: *Walsenburg,* 1 (UMMZ); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 1 (KU).

OTERO COUNTY: La Junta, 1 (USNM); JJ Ranch, Higbee, 1 (USNM). BENT COUNTY: Ninaview, 4 (DMNH). PROWERS COUNTY: Lamar, 2 (UMMZ); *S of Lamar,* 1 (DMNH); Two Buttes Reservoir, 1 (UI). LAS ANIMAS COUNTY: *Mesa de Maya,* 4 (UMMZ); 10 mi. SW Tobe, 1 (KU); Trinchera, 7 (DMNH); *no locality other than county,* 2 (DMNH). BACA COUNTY: Deora, 2 (DMNH); *Gaume's Ranch, 4600 ft.,* 9 (1 MCZ, 5 USNM, 3 WC); *Two Buttes Reservoir,* 1 (DMNH); near Monon, 3 (WC); *"The Cedars,"* 1 (WC); Jimmie Creek, 2 (DMNH); Regnier, 3 (DMNH).

Additional records: WELD COUNTY: 9 mi. N, 3 mi. E Nunn (Engel and Vaughan, 1966:143). CUSTER COUNTY: "Quenda" [probably Querida] (Nelson, 1909:284). CROWLEY COUNTY: *no precise locality* (Rapp, 1962:216).

Sylvilagus audubonii warreni Nelson

Sylvilagus auduboni [sic] warreni Nelson, Proc. Biol. Soc. Washington, 20:83, 22 July 1907; type locality, Coventry, Montrose Co., Colorado.

Distribution in Colorado.—Semiarid valleys and shrublands of western part of state, south of Book Cliffs, and in San Luis Valley (Fig. 35).

Comparison.—For comparison with *S. a. baileyi,* see account of that subspecies.

Measurements.—Average (and extreme) external measurements of eight males, followed by those of eight females, all from Montrose and Montezuma counties, are: 378.5 (360-399), 391.2 (362-407); 42.1 (35-51), 50.1 (40-61); 95.2 (86-101), 96.0 (89-100); 69.4 (66-72), 67.8 (60-72) (dry). For cranial measurements, see table 6.

Remarks.—*Sylvilagus a. warreni* apparently differs from *S. a. baileyi* only in color. Some individuals from southwestern Colorado may approach the pale color of *baileyi,* but specimens in fresh pelage generally are a rather homogeneous, distinctive lot. The ranges of the two Coloradan subspecies are well circumscribed by physiographic and vegetational barriers, and apparently no actual intergradation between *warreni* and *baileyi* occurs in the state, for the ranges of the two subspecies are nowhere in contact. Perhaps it should be pointed out, however, that *S. audubonii* never has been collected in the vicinity of the Grand Hogback in Rio Blanco and Garfield counties. This transect (from Meeker to Rifle) is a likely place for limited contact between populations of the two subspecies. Possibly intermittent contact is possible at Poncha Pass between the population of *warreni* in the San Luis Valley and *baileyi* in the Upper Arkansas Valley. The habitat at that pass today appears to me marginal for both *S. audubonii* and *S. nuttallii.*

Records of occurrence.—Specimens examined, 119, distributed as follows: GARFIELD COUNTY: Rifle, 2 (USNM). MESA COUNTY: Stateline, 1 (DMNH); 1 mi. SW Mack, 4600 ft., 1 (KU); 4 2/10 mi. NW Fruita, 1 (CSU); Grand Junction, 11 (7 DMNH, 4 WC); 20 mi. SW Grand Junction, 5500 ft., 1 (CSU); *no locality other than county,* 1 (DMNH). DELTA COUNTY: Hotchkiss, 2 (USNM); Delta, 4980 ft., 1 (MCZ); *sec. 11, T. 15 S, R. 95 W, 5000 ft.,* 1 (CSU). MONTROSE COUNTY: West Paradox Valley, 2 (DMNH); Paradox, 1 (USNM); *1 mi. N Bedrock, 4800 ft.,* 1 (CSU); Bedrock, 8 (4 AMNH, 4 WC); Coventry, 20 (3 AMNH, 1 CSU, 7 USNM, 9 WC). SAN MIGUEL COUNTY: *Norwood,* 4 (SC). SAGUACHE COUNTY: *Villa Grove,* 1 (WC); 3 mi. E Villa Grove, 1 (ASC); Crestone, 1 (WC); 5 mi. NW Hooper, 1 (DMNH); *9 mi. E Center,* 1 (AMNH). RIO GRANDE COUNTY: no locality other than county, 1 (USNM). ALAMOSA COUNTY: Medano Ranch, 3 (USNM); N of entrance station, Great Sand Dunes National Monument, 1 (GSDNM); *5 mi. W Alamosa,* 1 (ASC); Alamosa, 1 (CU); "Sangre de Cristo Range," 2 (AMNH). MONTEZUMA COUNTY: Ashbaugh's Ranch, 3 (2 USNM, 1 WC); Cortez, 9 (4 DMNH, 5 WC); Mancos, 1 (SC); Ute Peak, 6 (DMNH); Mancos River, 6200 ft., 1 (KU); *Far View Ruins, Mesa Verde National Park,* 1 (KU); Four Corners, 2 (DMNH). LA PLATA COUNTY: Bondad, 2 (DMNH); NW 1/4 sec. 15, T. 32 N, R. 6 W, 1 (UNM). ARCHULETA COUNTY: 2 1/2 mi. S, 1 mi. W Chimney Rock, 1 (UNM); sec. 23, T. 32 N, R. 6 W, 1 (UNM). CONEJOS COUNTY: Antonito, 1 (USNM). COSTILLA COUNTY: *Blanca,* 2 (UMMZ); Fort Garland, 12 (8 UMMZ, 4 USNM); 2 1/2 mi. S San Acacio, 1 (CSU); *no locality other than county,* 1 (USNM).

Additional records: MESA COUNTY (P. H. Miller, 1964:43): Rim Rock Drive, Colorado National Monument, 6640 ft.: *2 mi. E Rim Rock Drive, 6450 ft.* MONTEZUMA COUNTY (Anderson, 1961:40): *2 mi. E Cortez; head of Prater Canyon, Mesa Verde National Park.*

Lepus americanus

SNOWSHOE HARE

Lepus americanus is a boreal mammal and in Colorado is confined to mountainous parts of the state where coniferous forests provide favorable habitat. The altitudinal range is approximately 8000 to 11,000 feet, the zone of heaviest forests, although Warren (1942:259) stated that the species ". . . has been known as low as 6,500 feet in winter in Gunnison

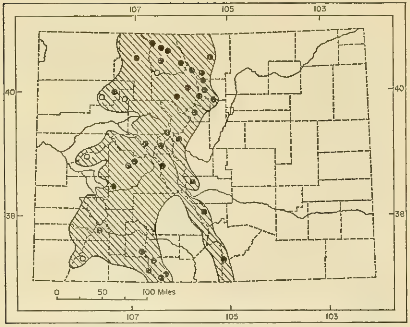


FIG. 36. Distribution of *Lepus americanus bairdii* in Colorado. For explanation of symbols, see p. 9.

County." Optimal cover for snowshoe hares is stands of brush in openings in the forest. Disturbance of forest by limited burning or logging tends to encourage such habitat. Probably habitat for snowshoe hares has been extended in Colorado by human interference. Porter (1959) reported on effects of timber-cutting on habitat of *L. americanus* on the Fraser Experimental Forest in Grand County.

Studies of populations and population cycles of snowshoe hares in Colorado have not been published. Statistics compiled by the Division of Game, Fish and Parks indicate wide fluctuations in numbers, however. In 1955, the harvest was 21,414, an average season bag of 4.9 animals per hunter. In 1960, 9089 individuals were harvested, 2.1 animals per hunter.

Lepus americanus bairdii Hayden

Lepus bairdii Hayden, Amer. Nat., 3:115, May 1869; type locality, Columbia Valley, Wind River Mountains, Fremont Co., Wyoming.

[Lepus americanus] var. *Bairdii*, J. A. Allen, Proc. Boston Soc. Nat. Hist., 17:431, 17 February 1875.

Distribution in Colorado.—Forested areas at higher elevations throughout mountainous portions of state (Fig. 36).

Measurements.—External measurements of three males and two females from Hot Sulphur Springs, Grand County, are: 395, 464, 412, 425, 426; 25, 52, 41, 31, 59; 140, 152, 138, 153, 150; 67, 70, 65, 71, 65 (dry); weight, 2 1/2, 2 3/4, 2 1/4, 2 1/16, 2 1/2 pounds. Selected cranial measurements are presented in table 7.

Records of occurrence.—Specimens examined, 91, distributed as follows: ROUTT COUNTY: Mystic, 1 (DMNH). JACKSON COUNTY: Mount Zirkel, 1 (DMNH); Boettcher Ranch, Lake John, 1 (DMNH); Walden, 1 (CU); *Medicine Bow Range,* 4 (DMNH); Coalmont, 9000 ft., 1 (DMNH); *Homestead Ranch,* 2 (1 AMNH, 1 DMNH); 3 mi. below Cameron Pass, 9450 ft., 1 (WC). LARIMER COUNTY: Pingree Park, 9200 ft., 1 (CSU); Milner Pass, 1 (KU); *Trail Ridge Road,* 3 (RMNP); *Bear Lake Road, 9000 ft.,* 1 (RMNP); Estes Park, 1 (KU). RIO BLANCO COUNTY: Ute Creek, 8000 ft., 1 (AMNH). EAGLE COUNTY: 12 mi. N, 1 mi. W Leadville, 1 (KU); *Pando,* 3 (DMNH); *no locality other than county,* 2 (FMNH). GRAND COUNTY: Hot Sulphur Springs, 8000 ft., 5 (WC); *Coulter,* 1 (USNM); Upper Williams Fork, Middle Park, 1 (CU). BOULDER COUNTY: foot of Mount Meeker, 9000 ft., 1 (AMNH); *NW of Ward, 9500 ft.,* 1 (CU); near Ward, 9000 ft., 3 (CU); *7 mi. NW Nederland,* 2 (UMMZ); Silver Lake, 10 (CU); *Rainbow Lakes, near Silver Lake,* 1 (CU); Coal Creek Canyon, 1 (FWS); *no locality other than county,* 1 (DMNH). CLEAR CREEK COUNTY: Silverplume, 1 (DMNH). PITKIN COUNTY: Hunters Creek, near Aspen, 1 (DMNH). LAKE COUNTY: 11 mi. SW Leadville, 1 (KU). PARK COUNTY: no locality other than county, 1 (DMNH). GUNNISON COUNTY: *2 mi. N Rocky Mountain Biological Laboratory,* 1 (AMNH); *1 mi. N Gothic,* 1 (KU); Gothic, 1 (ANSP); Irwin, 10,700 ft., 1 (WC); *Lake Brennan, near Irwin, 10,500 ft.,* 1 (WC); *divide between Sapinero and Curecanti creeks, 9200 ft.,* 1 (WC); sec. 7, T. 49 N, R. 4 W, NW of Sapinero, 1 (WC); *Flat Top Mountain* (not found), 1 (WSC). FREMONT COUNTY: no locality other than county, 1 (DMNH). CUSTER COUNTY: no locality other than county, 1 (DMNH). SAN JUAN COUNTY: Silverton, 9 (USNM). MINERAL COUNTY: 23 mi. S, 11 mi. E Creede, 9300 ft., 2 (KU); *24 mi. S, 11 mi. E Creede, 9300 ft.,* 1 (KU). HUERFANO COUNTY: head of Cucharas River, 1 (DMNH). ARCHULETA COUNTY: Navajo River, 5 (3 AMNH, 2 DMNH). CONEJOS COUNTY: *1 mi. W Platoro,* 1 (FHSC); *1/2 mi. W Platoro,* 1 (FHSC); 2 mi. E Platoro, 1 (FHSC); *4 mi. SW Platoro,* 1 (FHSC); 12 mi. NE Cumbres, 8800 ft., 1 (AMNH); 5 mi. S, 24 mi. W Antonito, 9600 ft., 1 (KU).

Additional records: JACKSON COUNTY: [near] Lake Agnes (Yeager, 1950:329). RIO BLANCO COUNTY: about Buford (Felger, 1910:144). GARFIELD COUNTY: Trappers Lake (Yeager, 1950: 329). BOULDER COUNTY: *Silver Lake Mine* (Elliot, 1907:384). PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:35). DELTA COUNTY: 6 mi. E Skyway, 10,000 ft. (Anderson, 1959a:409). GUNNISON COUNTY: *Gothic Natural Area, 2 mi. NW Gothic, 10,200 ft.* (Findley and Negus, 1953: 239). LA PLATA COUNTY: 8 mi. N, 1 mi. W Hesperus (Finley, 1959:592).

TABLE 7

Selected cranial measurements of three species of *Lepus*.

Number averaged (or catalog number), sex	Greatest length of skull	Zygomatic breadth	Postorbital breadth	Length of incisive foramen	Least length of palatal bridge	Length of nasals	Length of maxillary toothrow
Lepus americanus bairdii, vicinity of Hot Sulphur Springs, Grand County							
WC 2061, ♂	78.3	36.9	9.6	19.4	5.1	32.3	13.4
WC 2017, ♀	73.5	37.4	12.3	18.5	5.4	29.1	13.0
WC 2071, ♀	72.9	38.2	11.6	18.6	5.2	29.2	13.6
Lepus townsendii campanius, Larimer and Boulder counties							
Mean, 4 ♂	92.13	44.65	12.08	22.72	6.20	39.90	16.98
Minimum	90.4	44.2	11.5	21.8	5.2	36.8	16.5
Maximum	94.0	45.1	12.6	23.7	7.1	41.4	17.5
Mean, 5 ♀	94.56	44.18	13.68	24.28	6.48	40.28	16.58
Minimum	93.4	42.1	12.8	22.9	6.1	38.4	15.8
Maximum	95.6	45.8	14.7	25.6	7.0	43.6	17.5
San Luis Valley							
Mean, 5 ♂	93.94	44.78	13.48	23.64	6.30	38.24	17.40
Minimum	90.5	42.6	11.8	22.7	5.0	34.9	16.7
Maximum	96.0	46.4	14.9	24.6	7.0	40.9	18.0
WC 3496, ♀	95.4	44.6	12.2	23.6	5.0	36.5	17.4
WC 2735, ♀	94.2	45.0	11.1	23.9	5.3	39.5	16.5
CSU 9420, ♀	95.6	45.8	12.7	24.1	6.4	39.0	17.0
Lepus townsendii townsendii, Grand and Eagle counties							
WC 570, ♂	92.4	44.4	13.4	22.4	6.0	39.1	16.2
WC 2081, ♂	95.5	——	14.2	24.0	6.0	41.7	15.8
WC 2025, ♂	93.7	45.0	12.4	23.1	4.4	41.8	17.0
Mean, 6 ♀	93.91	44.92	13.74	23.62	5.88	38.92	16.33
Minimum	91.9	44.2	12.6	23.0	5.2	37.4	15.9
Maximum	96.8	44.9	14.7	24.5	6.6	41.1	17.2
Lepus californicus melanotis, Larimer County							
CSU 8579, ♂	97.4	43.2	11.4	23.4	7.7	——	16.9
CSU 10252, ♂	97.7	43.3	12.6	25.5	6.4	42.3	16.5
CSU 10614, ♂	——	44.0	12.8	25.0	6.5	——	16.5
CSU 10529, ♀	——	43.6	12.2	26.4	6.2	41.4	17.1
CSU 10992, ♀	90.9	43.7	12.1	22.7	6.2	35.6	15.8
Lepus californicus texianus, Coventry, Montrose County							
WC 2851, ♂	99.0	43.8	11.4	25.4	7.0	40.7	16.7
WC 1783, ♀	93.0	44.7	14.5	23.9	6.8	41.0	16.0
WC 2854, ♀	92.5	42.9	14.8	23.4	6.1	36.4	14.8

Lepus townsendii

WHITE-TAILED JACKRABBIT

The white-tailed jackrabbit is a mammal of the Great Plains, the northern Great Basin, and adjacent mountainous areas. Essentially an animal of open country, *Lepus townsendii* is abundant in the mountain parks and in the San Luis Valley. The altitudinal range of the species in Colorado is as broad as that of any mammal—from below 5000 feet on the eastern plains to well above timberline. Braun and Streeter (1968) presented detailed observations on white-tailed jackrabbits above timberline in Larimer, Clear Creek, and Chaffee counties. Hoeman (1964) reported *L. townsendii* from the summits of Mount Bierstadt (14,060 feet) and Mount Bross (14,169 feet).

An excellent study of the autecology of *L. townsendii* in the vicinity of Cochetopa Park, Saguache County, was reported by Bear and Hansen (1966). Hansen and Flinders (1969) reviewed the literature on food habits of North American species of *Lepus*.

Jones (1964:111) detailed reduction of the range of *L. townsendii* in Nebraska and the concomitant northward spread of *L. californicus*. A similar trend has occurred in eastern Colorado over the past 60 years. Burnett and McCampbell (1926b) reported that white-tailed jackrabbits were more abundant than black-tailed jackrabbits in northeastern Colorado until the period 1912 to 1914. Black-tailed jackrabbits were regarded as a curiosity at New Raymer, Weld County, in 1910; in 1926, 70 per cent of jackrabbits taken were *L. californicus*. Warren (1942:263) presented some details of changes in relative abundance of the two species in the vicinity of Colorado Springs. Prior to agricultural development of the eastern plains, the Arkansas River evidently marked the approximate boundary between ranges that were essentially complementary. At present, white-tailed jackrabbits occur sparingly over much of east-central and northeastern Colorado, and are locally common on rangelands that have not been overgrazed by domestic stock. Wherever the land has been broken for cultivation or the range degraded by *Opuntia* following overgrazing or drought, *L. californicus* seems to exclude the larger *L. townsendii*. Whether the mutual adjustments of ranges of these two species are a direct response to the changing ecology of the plains or a result of competition is not known. Jones (1964:113) suggested that the warming trend now in evidence in North America may be a factor influencing the observed changes in ranges.

In southwestern Colorado, *L. townsendii* occurs in mountain parks, whereas *L. californicus* occurs in warm, dry valleys. Adjustments of ranges of jackrabbits in that part of the state have not been documented. The more complex topography of the western fourth of Colorado should preclude any but the most local changes.

Because jackrabbits are not protected under Colorado law, data on annual harvests are not available. The harvest is considerable, however, for in addition to hunting for "sport," and limited use for food, jackrabbits are of some commercial value. The fur is used in the manufacture of felt and carcasses are used as feed on fur ranches. According to Bear and Hansen (1966:iii), in some years as many as 65,000 animals have been handled at a collection point in Craig.

Lepus townsendii campanius Hollister

Lepus campestris Bachman, Jour. Acad. Nat. Sci. Philadelphia, 7:349, 1837; type locality, Saskatchewan, probably near Carlton House [now Carlton]. Not *Lepus cuniculus campestris* Meyer, 1790.

Lepus townsendii campanius Hollister, Proc. Biol. Soc. Washington, 28:70, 12 March 1915; a replacement name for *L. campestris* Bachman.

Distribution in Colorado.—East of Continental Divide in mountains, San Luis Valley, and on eastern plains north of Arkansas River (Fig. 37).

Comparison.—From *L. t. townsendii*, the subspecies of the Western Slope, *L. t. campanius* differs in that the tail generally lacks a black dorsal stripe, and in summer pelage the dorsum is washed with buff rather than being uniformly gray. Winter pelage of Coloradan specimens rarely is completely white; more typically it is white with a buffy wash in *campanius*, grayish white in *townsendii*. Topotypes of *townsendii* average slightly smaller than specimens of *campanius* from the Great Plains in both external and cranial measurements.

Measurements.—External measurements of two males and two females from Larimer County are: 550, 587, 575, 578; 85, 74, 74, 82; 155, 143, 140, 130; 110, 112, 110, —; weights, 5.6 pounds, 5.8 pounds, 2975 gr., 2410 gr. Mean (and extreme) external measurements of six males, followed by those of five females, all from the San Luis Valley, are: 593.2 (570-611), 607.6 (588-633); 81.2 (70-92), 89.2 (76-98); 153.3 (138-162), 154.0 (148-165); 106.3 (99-110), 103.0 (90-113) (dry); weights of four males, 6.5, 7, 6, 6 pounds, of two females, 8 1/4, 7 1/2 pounds. Selected cranial measurements are presented in table 7.

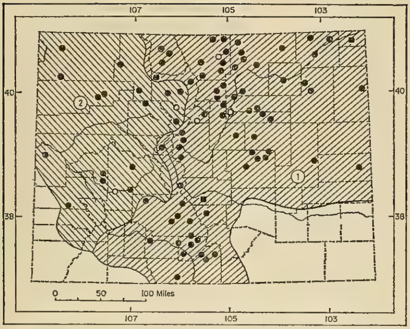


FIG. 37. Distribution of *Lepus townsendii* in Colorado. 1. *L. t. campanius.* 2. *L. t. townsendii.* For explanation of symbols, see p. 9.

Remarks.—In Colorado, named kinds of *L. townsendii* differ most notably in a single character, the presence or absence of a black caudal stripe. The stripe is most marked in specimens from localities on the Western Slope at relatively low elevations (for example, Coventry and Crawford). Specimens from the San Luis Valley typically show a fine gray line on the tail, and those from the Park Range and environs are generally without a caudal stripe, or with a pale gray stripe only. Probably those animals from the central part of the state are best considered to be intergrades between the rather different subspecies of the Great Plains and the northern part of the Great Basin. A broad zone of intergradation is to be expected, for the high mountains of central Colorado are a weak barrier to a species with such broad ecological amplitude. The line between ranges of the two subspecies in figure 37 is placed arbitrarily along the Continental Divide.

Records of occurrence.—Specimens examined, 149, distributed as follows: JACKSON COUNTY: Boettcher Ranch, Lake John, 1 (DMNH); *Hell Creek,* 1 (WC); *3 mi. N Walden,* 1 (CSU); *North Platte River,* 1 (DMNH); Walden, 4 (DMNH); Coalmont, 1 (DMNH); *near Bighorn Ranch* (not found), 1 (WC). LARIMER COUNTY: 35 mi. N Fort Collins, 1 (CSU); 14 mi. N Livermore, sec. 29, T. 12 N, R. 70 W, 1 (KU); *3 mi NW Wellington,* 1 (CU); Wellington, 2 (1 CSC, 1 CSU); *7 mi. N, 4 mi. E Fort Collins,* 1 (CSC); *7 1/2 mi. NE Fort Collins,* 1 (CSU); *2 mi. NE Fort Collins,* 1 (CU); *1 1/2 mi. N, 3 mi. E Fort Collins,* 1 (CU); *1 1/2 mi. SW Fort Collins,* 2 (1 CSU, 1 CU); Bull Mountain, sec. 17, T. 7 N, R. 73 W, 1 (CSU); *5 mi. SW Fort Collins,* 1 (CU); *sec. 23, T. 7 N, R. 68 W,* 1 (CU); *4 mi S, 1 mi. W Fort Collins,* 2 (CSU); 5 mi. S, 2 mi. W Fort Collins, 1 (CSU); Loveland, 5 (USNM); near utility entrance, Rocky Mountain National Park, 1 (RMNP). WELD COUNTY: Rockport, 3 (DMNH); Pawnee Buttes, 1 (DMNH); 2 mi. NE Nunn, 1 (CU); *1/2 mi. W Nunn,* 1 (CSC); *4 mi. E Nunn,* 1 (FHSC); Pawnee National Grassland, NE of Ault, 1 (CSU); Cornish, 1 (CU); *5 mi. N Gill,* 1 (CSU); 6 mi. N Windsor, 1 (CSU); 4 mi. E Fort Lupton, 1 (CU); *no locality other than county,* 1 (DMNH). MORGAN COUNTY: Fort Morgan, 1 (UMMZ). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU); Crook, 1 (DMNH); Sterling, 1 (USNM). SEDGWICK COUNTY: no locality other than county, 1 (KU). SUMMIT COUNTY: near Boreas Pass, 12,000 ft., 2 (WC). BOULDER COUNTY: Longmont, 1 (DMNH); 7 mi. N Boulder, 1 (CU); Lefthand Canyon, 1 (CU); 3 mi. S Boulder, 1 (CU). CLEAR CREEK COUNTY: Mill City, 1 (AMNH). JEFFERSON COUNTY: 3 mi. N Arvada, 1 (CSU); *12 mi. S Boulder,* 1 (CU); Deer Creek, 1 (MCZ). ADAMS COUNTY: 5 mi. E Brighton, 2 (FWS); Watkins, 3 (DMNH); Bennett, 4 (DMNH). ARAPAHOE COUNTY: Strasburg, 9 (DMNH); Deer Trail, 1 (AMNH). WASHINGTON COUNTY: 8 mi. W Akron, 1 (UMMZ); 10 mi. S Akron, 1 (UMMZ). YUMA COUNTY: Wray, 1 (CU); *no locality other than county,* 1 (DMNH). LAKE COUNTY: 6 mi S, 4 mi. W Leadville, 1 (CU). PARK COUNTY: *Mount Bross, 13,000 ft.,* 1 (DMNH); Como, 1 (USNM); 1 1/2 mi. E Fairplay, 1 (DMNH); 17 mi. S Fairplay, 1 (CSU); *no locality other than county,* 1 (DMNH). DOUGLAS COUNTY: Castle Rock, 1 (DMNH). ELBERT COUNTY: *2 mi. NE Kiowa,* 1 (UMMZ); 1 mi. SE Kiowa, 1 (CU); *2 mi. S Kiowa,* 1 (CU); *3 mi. S Kiowa,* 1 (CU). LINCOLN COUNTY: Boyero, 1 (DMNH). KIT CARSON COUNTY: Burlington, 1 (UMMZ). CHAFFEE COUNTY: Salida, 7000 ft., 1 (WC); *no locality other than county,* 1 (DMNH). EL PASO COUNTY: Ramah, 1 (UMMZ); Peyton, 1 (WC); *3 mi. SE Peyton,* 1 (UMMZ); near Calhan, 1 (WC); Eastonville, 1 (WC); 15 mi. E Colorado Springs, 1 (WC). SAGUACHE COUNTY: Cochetopa Park, 26 mi. SE Gunnison, 1 (CSU); Villa Grove, 5 (1 AMNH, 4 WC); Sagauche, 1 (WSC); 8 mi. E Moffat, 1 (UI); 11 mi. SW Saguache, 1 (DMNH); 5 mi. NW Hooper, 1 (DMNH); *3 mi. N Hooper, 7562 ft.,* 1 (WC); *9 mi. E Center,* 1 (AMNH); *no locality other than county,* 1 (AMNH). FREMONT COUNTY: no locality other than county, 1 (DMNH). CUSTER COUNTY: Westcliffe, 1 (WC); *no locality other than county,* 1 (DMNH). RIO GRANDE COUNTY: U.S. Highway 160 to Beaver Creek Reservoir, 1 (FWS); 5 mi. NE Monte Vista, 3 (UI). ALAMOSA COUNTY: *Hooper,* 1 (WC); *Medano Ranch,* 7 (5 USNM, 2 WC); San Luis Lake, 1 (WC); Mosca, 7 (2 AMNH, 5 WC); *5 mi. NW Alamosa,* 1 (ASC); 7 mi. W Alamosa, 1 (ASC);

12 mi. W Alamosa, 1 (SCSC). CONEJOS COUNTY: Antonito, 1 (USNM); *no locality other than county,* 1 (DMNH). COSTILLA COUNTY: 20 mi. W La Veta, 1 (WC); 7 mi. W Blanca, 1 (KU); Fort Garland, 2 (1 AMNH, 1 USNM).

Additional records: LARIMER COUNTY: "Cache la Poudre Creek, Neb." (Baird, 1858:589); *Trilby* (Markham, 1907:146). WELD COUNTY: *9 mi. N, 3 mi. E Nunn* (Engel and Vaughan, 1966:143). CLEAR CREEK COUNTY (Hoeman, 1964:495): *Mount Evans, 13,800 ft.;* summit Mount Bierstadt, 14,060 ft. DENVER COUNTY: Denver (Nelson, 1909:74). PARK COUNTY: *Mount Lincoln, above timberline* (Hoeman, 1964:495); *summit of Mount Bross, 14,169 ft.* (Hoeman, *loc. cit.*); *Alma* (Warren, 1942:257). SAGUACHE COUNTY: *2 mi. SW Doyleville* (Sparks, 1968a:324); *Cochetopa Dome* (Hansen and Bear, 1963:420). County unknown: *East Dale* (Nelson, *loc. cit.*).

Lepus townsendii townsendii Bachman

Lepus townsendii Bachman, Jour. Acad. Nat. Sci. Philadelphia, 8:90, pl. 2, 1839; type locality, Fort Walla Walla, Walla Walla Co., Washington.

Distribution in Colorado.—In suitable habitat west of Continental Divide (Fig. 37).

Comparison.—For comparison with *L. t. campanius,* see account of that subspecies.

Measurements.—External measurements of three males from Grand County are: 570, 600, 600; 80, 100, 90; 157, 153, 170; 107, 109, 109 (dry); weights, 6 1/2, —, 6 1/4 pounds. Mean (and extreme) measurements of six females from Grand and Eagle counties are: 609.2 (590-640); 99.8 (87-105); 160.7 (153-166); 103.8 (99-110) (dry); mean weight of five females from Grand County, 6.8 (6.4-7.5) pounds. Cranial measurements are presented in table 7.

Records of occurrence.—Specimens examined, 47, distributed as follows: MOFFAT COUNTY: 23 mi. N, 34 mi. W Maybell, 1 (KU); 3 mi. E Massadona, 1 (KU); *no locality other than county,* 1 (DMNH). ROUTT COUNTY: near Hayden, 1 (DMNH); Wright's Ranch, near Yampa, 7700 ft., 3 (1 AMNH, 2 WC). RIO BLANCO COUNTY: South Fork, White River, 7000 ft., 1 (AMNH); Dry Fork, White River, 6200 ft., 3 (AMNH); *Dry Fork, White River,* 5 (AMNH); *Compass Creek, 9000 ft.* (not found), 1 (AMNH). EAGLE COUNTY: near McCoy, 1 (WC). GRAND COUNTY: Grand Lake, 1 (FWS); Mount Whitely, 1 (USNM); Hot Sulphur Springs, 8 (WC); 5 mi. above Kremmling, 7800 ft., 1 (WC); *Middle Park,* 1 (CU); *no locality other than county,* 1 (DMNH). SUMMIT COUNTY: Dillon, 2 (DMNH). MESA COUNTY: 1/2 mi. W Glade Park Road on Rim Rock Drive, 6470 ft., 1 (CNM). DELTA COUNTY: near Crawford, 1 (WC). GUNNISON COUNTY: Crested Butte, 1 (WC); *near "W" Mountain, Gunnison,* 1 (WSC); 4 mi. W Gunnison, 1 (WSC). MONTROSE COUNTY: Maher, 7000 ft., 4 (WC); Coventry, 4 (1 USNM, 3 WC).

Additional records: RIO BLANCO COUNTY (Felger, 1910:144): *Buford; Little Beaver Creek.* SUMMIT COUNTY: Baldy Mountain (Nelson, 1909: 78). MESA COUNTY: *Colorado Highway 340, 1/2 mi. W Fruita Entrance, Colorado National Monument* (P. H. Miller, 1964:39). GUNNISON COUNTY (Durrant and Robinson, 1962:243): *Gunnison River, 3 mi. E Dry Gulch, 7600 ft.; 1/4 mi. above confluence Red Creek and Gunnison River, 7350 ft.; Soap Creek, 6000 ft., 2 mi. from Sapinero;* Gunnison River, near Sapinero.

Lepus californicus

BLACK-TAILED JACKRABBIT

The black-tailed jackrabbit is a widespread and abundant mammal on the southern and central Great Plains, in the Great Basin, and through southwestern United States and adjacent Mexico. In western Colorado, *Lepus californicus* occupies semiarid valleys at elevations up to about 7000 feet. On the Eastern Slope, black-tailed jackrabbits are abundant up to elevations of about 6000 feet, and may range somewhat higher locally in dry, open canyons in the foothills.

Lepus californicus has extended its range in eastern Colorado in the present century, apparently a result of expansion of agriculture on the plains. For comments on changes in distributional patterns of Coloradan jackrabbits, see the account of *Lepus townsendii.*

Black-tailed jackrabbits are an important ecological influence on rangelands in Colorado. Costello (1944b) studied the influence of *L. californicus* on succession on abandoned plowed land in Weld County. Sanderson (1959) found that heavily grazed range supported higher numbers of jackrabbits than moderately grazed lands. Overgrazing by domestic stock upset the primary production on the range, which favored an increase in the number of jackrabbits. In such cases, the hares are blamed for deterioration of the range. Once the range has been damaged by domestic animals, of course, the high populations of jackrabbits do encourage further deterioration. For example, black-tailed jackrabbits are important in furthering the spread of prickly-pear, *Opuntia polyacantha* (see Turner and Costello, 1942). Sparks (1968b) investigated

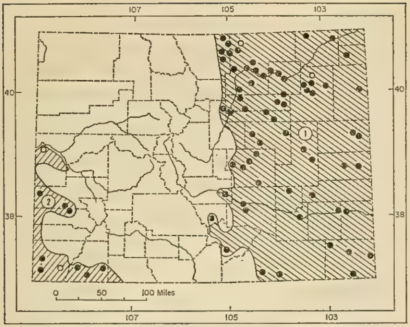


FIG. 38. Distribution of *Lepus californicus* in Colorado. 1. *L. c. melanotis*. 2. *L. c. texianus*. For explanation of symbols, see p. 9.

the diet of black-tailed jackrabbits on sandhills grassland in northern Washington County. For a brief review of food habits and the ecological importance of *L. californicus*, see Hansen and Flinders (1969).

Due to large local populations and a tendency to augment the degradation of poorly managed range, black-tailed jackrabbits have become serious agricultural pests in parts of eastern Colorado. In the 1890's, "Rabbit Days" were instituted at Lamar and Las Animas. In December 1894, 101 hunters shot 5142 jackrabbits in the vicinity of Lamar in one and one-half days (for comments and illustration, see Palmer, 1897:63 and pl. 6). According to Warren (1942:266), in the three years 1893 through 1895, 32,000 jackrabbits were killed in Las Animas and Prowers counties in organized hunts. For additional remarks on the history of control measures in Colorado, see Palmer (1897), Burnett and McCampbell (1926b), and Warren (1942).

Lepus californicus melanotis Mearns

Lepus melanotis Mearns, Bull. Amer. Mus. Nat. Hist., 2:297, 21 February 1890; type locality, near Independence, Montgomery Co., Kansas.

Lepus californicus melanotis, Nelson, N. Amer. Fauna, 29:146, 31 August 1909.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 38).

Comparison.—From *L. c. texianus*, the subspecies of the southwestern part of the state, *L. c. melanotis* differs in brighter, more buffy (less grayish) color of upper parts, and smaller auditory bullae.

Measurements.—External measurements of two males and two females from Larimer County are: 490, 570, 459, 580; 89, 79, 72, 65; 137, 123, 137, 130; 119, 125, 110, 119; weight, —, 3445, 4996, 2395. Cranial measurements are presented in table 7.

Remarks.—Nelson (1909:145) noted that ". . . along both sides of the Rocky Mountains in Colorado is a belt in which most of the [black-tailed] jackrabbits are evidently intergrades between *texianus* and *melanotis*. . . ." In fact, intergradation cannot occur in Colorado because the ranges of the two subspecies are not in contact there. It is nonetheless true that specimens of *texianus* from southwestern Colorado and specimens of *melanotis* from the eastern plains tend to resemble one another to a greater extent than do topotypes of the two subspecies. This similarity between the Coloradan populations may be an effect of actual intergradation between subspecies where the ranges meet in New Mexico, or a matter of convergence due to similar selective pressures or similar environmental influences on development (or both).

Records of occurrence.—Specimens examined, 158, distributed as follows: LARIMER COUNTY: 30 mi. N Fort Collins, 2 (DMNH); 6 mi. E Buckeye, 5100 ft., 1 (CSU); *7 mi. N Fort Collins*, 1 (CSU); 2 mi. NE La Porte, 5200 ft., 1 (CSU); *2 mi. S Cobb Lake*, 1 (CSU); *NE 1/4 sec. 1, T. 8 N, R. 69 W*, 1 (CSU); 5 mi. N, 3 mi. E Fort Collins, 1 (CSC); *2 mi. N, 1/4 mi. W Fort Collins*, 1 (CSU); Fort Collins, 2 (DMNH). WELD COUNTY: 2 mi. NE Nunn, 1 (CSU); 5 mi. N Gill, 1 (CSU); *NE of Greeley*, 1 (CSC); Greeley, 1 (FWS); 4 mi. N Johnstown, 1 (CSU); 8 mi. E Kersey, 1 (CSC); 28 mi. W Fort Morgan, 2 (UMMZ); 10 mi. NE Hudson, 2 (CU); *1 1/2 mi. E Fort Lupton*, 1 (CSU); 3 mi. E Fort Lupton, 1 (CU); *Hudson*, 4 (3 CU, 1 DMNH); *no locality other than county*, 1 (DMNH). MORGAN COUNTY: Jackson Reservoir, 3 (DMNH); Weldona, 1 (DMNH); 2 mi. S Fort Morgan, 2 (WC). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 2 (KU); Crook, 7 (2 AMNH, 5 DMNH). PHILLIPS COUNTY: 5 mi. W Holyoke, 1 (UNM). JEFFERSON COUNTY: Semper, 1 (DMNH). ADAMS COUNTY: 25 mi. S Fort Morgan, 3 (UMMZ); Barr, 2 (WC); *30 mi. S Fort Morgan*, 6 (UMMZ); 3 mi. N Leader, 1 (UMMZ); 3 mi. S, 1 mi. W Simpson, 1 (KU); Watkins, 1 (DMNH); *no locality other than county*, 2 (1 DMNH, 1 UMMZ). DENVER COUNTY: Denver, 3 (2 KU, 1 USNM). ARAP-

AHOE COUNTY: Strasburg, 2 (DMNH); Deer Trail, 2 (1 AMNH, 1 UMMZ). WASHINGTON COUNTY: 8 mi. W Akron, 15 (UMMZ); Akron, 3 (UMMZ); Otis, 1 (FWS); 10 mi. SW Akron, 1 (UMMZ); 10 mi. S Akron, 1 (UMMZ). YUMA COUNTY: Wray, 4 (1 AMNH, 1 USNM, 2 WC); *no locality other than county,* 1 (DMNH). ELBERT COUNTY: 6 mi. N Riverbend, 1 (CU); Kiowa, 2 (DMNH); 1 mi. N Fondis, 1 (UMMZ). LINCOLN COUNTY: Hugo, 3 (1 DMNH, 1 FWS, 1 KU); Boyero, 5 (DMNH). KIT CARSON COUNTY: 10 mi. NW Burlington, 1 (CSU); Burlington, 2 (1 UMMZ, 1 USNM). EL PASO COUNTY: Peyton, 6700 ft., 1 (WC); *3 mi. SE Peyton,* 1 (UMMZ); *7 mi. from Peyton,* 1 (WC); 4 mi. E Falcon, 1 (UMMZ); 3 mi. N Colorado Springs, 1 (WC); 15 mi. E Colorado Springs, 3 (1 AMNH, 2 WC); 16 mi. E Wigwam, 2 (CU). CHEYENNE COUNTY: 2 mi. S Firstview, 2 (CU); 1/2 mi. E Cheyenne Wells, 1 (CSU); *no locality other than county,* 1 (DMNH). FREMONT COUNTY: no locality other than county, 1 (DMNH). CUSTER COUNTY: no locality other than county, 1 (DMNH). PUEBLO COUNTY: 2 mi. SW Pueblo, 1 (SCSC); 12 mi. S Pueblo, 1 (SCSC); *no locality other than county,* 2 (DMNH). CROWLEY COUNTY: 20 mi. N Ordway, 2 (KU). KIOWA COUNTY: Arlington, 1 (USNM); *no locality other than county,* 1 (DMNH). OTERO COUNTY: La Junta, 1 (USNM). HUERFANO COUNTY: 4 mi. W La Veta, 7100 ft., 1 (KU); *no locality other than county,* 1 (DMNH). BENT COUNTY: Prowers, 5 (DMNH); *no locality other than county,* 1 (DMNH). PROWERS COUNTY: Lamar, 3 (UMMZ); *SW of Lamar,* 1 (WC); *no locality other than county,* 1 (DMNH). LAS ANIMAS COUNTY: 1 mi. S, 7 mi. W Trinidad, 4 (KU); Trinchera, 1 (DMNH); *no locality other than county,* 1 (DMNH). BACA COUNTY: The Cedars, 1 (WC); S of Springfield, 1 (WC); near Monon, 1 (WC); Regnier, 2 (DMNH).

Additional records: WELD COUNTY: 9 mi. N, 3 mi. E Nunn (Engel and Vaughan, 1966:143). WASHINGTON COUNTY: 17 mi. N Akron (Sparks, 1968a:325). EL PASO COUNTY: *Colorado Springs* (Nelson, 1909:148); *Colorado Springs Canyon* (not found) (Nelson, *loc. cit.*); *SE of Colorado Springs* (Esch *et al.*, 1959:442).

Lepus californicus texianus Waterhouse

Lepus texianus Waterhouse, A natural history of the Mammalia, 2:136, 1848; type locality, probably western Texas.

Lepus californicus texianus, Nelson, N. Amer. Fauna, 29:142, 31 August 1909.

Distribution in Colorado.—At lower elevations in southwestern part of state, generally south of Colorado and Gunnison rivers and west of San Juan Mountains (Fig. 38).

Comparison.—For comparison with *L. c. melanotis,* see account of that subspecies.

Measurements.—External measurements of a male and two females from Coventry, Montrose County, are: 605, 610, 566; 100, 95, 89; 144, 145, 140; 125, 131, 114 (dry). Selected cranial measurements are presented in table 7.

Records of occurrence.—Specimens examined, 27, distributed as follows: MESA COUNTY: *no locality other than county,* 1 (DMNH). MONTROSE COUNTY: West Paradox Valley, 1 (DMNH); Coventry, 11 (7 USNM, 4 WC). SAN MIGUEL COUNTY: Norwood, 1 (WC). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 1 (WC); Ute Peak, 9 (DMNH). LA PLATA COUNTY: Fort Lewis, 1 (WC); Bayfield, 1 (USNM); Bondad, 1 (DMNH).

Additional records: MESA COUNTY (P. H. Miller, 1964:41): Monument Mesa Patrol Road, about 2 mi. E Rim Rock Drive, 6450 ft., Colorado National Monument; *Rim Rock Drive, 1/2 mi. W Red Canyon Overlook, 6393 ft.* MONTEZUMA COUNTY: Mesa Verde National Park (Anderson, 1961:39).

Order RODENTIA

Fifty-six species of native rodents representing seven families occur in Colorado. In addition, two (possibly three) commensal kinds of Old World rodents inhabit parts of the state, and feral populations of the nutria *(Myocastor coypus)* and perhaps other exotic rodents also are known. Rodents far outnumber other orders of mammals in numbers of individuals as well as numbers of species.

Due to its geographic position and ecological complexity, Colorado supports a number of groups of closely related species of rodents in close proximity to one another. The genera *Peromyscus* and *Neotoma* each are represented by six species and the genera *Spermophilus* and *Perognathus* each have five species in the state. Four species of chipmunks *(Eutamias)* and pocket gophers (Geomyidae) occur in Colorado, as do three kinds of prairie dogs *(Cynomys).* Ecological relationships within some of these groups *(Neotoma, Cynomys,* geomyids, for example) have been investigated in some detail, but much remains to be learned.

Because of predator-prey imbalance due to intensive agriculture and programs to eradicate some major carnivores, local populations of certain rodents are sufficiently large to be of considerable economic importance. Obviously, specific local control programs sometimes are necessary to prevent serious loss. In general, however, protection of native rodents and their habitat should be a goal of any sound management program. The fox squirrel *(Sciurus niger)* is subject to licensed hunting and the muskrat and beaver are fur-bearers managed on a sustained-yield basis. Probably other kinds of native rodents should be given protection under the law.

KEY TO FAMILIES OF RODENTS IN COLORADO

1. Infraorbital foramen ovoid, larger than foramen magnum; pelage of upper parts in part modified to form stout quills .... Erethizontidae
   Infraorbital foramen smaller than foramen magnum; pelage variable, but not modified to form quills 2
2. Tail dorsoventrally flattened, nearly hairless; nostrils and ears valvular .... Castoridae
   Tail not dorsoventrally flattened; nostrils and ears not valvular 3
3. Infraorbital foramen small; lower premolars present, total teeth 20 or more 4
   Infraorbital foramen of moderate size, narrow, vertically elongate; lower premolars lacking, total teeth 18 or fewer 6
4. Prominent postorbital process present; external fur-lined cheek pouches lacking .... Sciuridae
   Prominent postorbital process lacking; external fur-lined cheek pouches present 5
5. Skull heavy, angular, zygomatic breadth greater than mastoid breadth; bullae moderately inflated, not cancellous; tail short, less than three-fourths length of head and body .... Geomyidae
   Skull light, zygomatic breadth less than mastoid breadth; bullae highly inflated, cancellous; tail relatively long, greater than three-fourths length of head and body .... Heteromyidae
6. Infraorbital foramen ovoid, upper premolars present; hind foot and tail markedly elongate .... Zapodidae
   Infraorbital foramen not ovoid, upper premolar absent; neither hind foot nor tail markedly elongate 7
7. Cheekteeth prismatic or with cusps in two longitudinal rows; tail, when round, well-haired, not obviously scaly .... Cricetidae
   Cheekteeth with cusps in three longitudinal rows; tail round, scaly, nearly naked .... *Muridae

FAMILY SCIURIDAE—SQUIRRELS

KEY TO SPECIES OF SCIURIDAE IN COLORADO

1. Tail less than one-fourth total length 2
   Tail greater than one-fourth total length 5
2. Maxillary toothrows roughly parallel; condylobasal length more than 80; forefeet with four clawed digits .... *Marmota flaviventris*
   Maxillary toothrows convergent posteriorly; condylobasal length less than 70; forefeet with five clawed digits 3
3. Jugal robust, laterally expanded in ventral aspect; tip of tail black .... *Cynomys ludovicianus*
   Jugal not markedly robust, not laterally expanded in ventral aspect; tip of tail grayish buff to white 4
4. Tip of tail usually white .... *Cynomys leucurus*
   Tip of tail usually grayish .... *Cynomys gunnisoni*
5. Zygomatic arches nearly parallel 6
   Zygomatic arches not parallel, convergent anteriorly 9
6. Loose fold of skin between forelimbs and hind limbs; interorbital region narrow, deeply notched .... *Glaucomys sabrinus
   No loose fold of skin between forelimbs and hind limbs; interorbital region relatively broad, not deeply notched 7
7. Total length less than 360; P3 vestigial or absent .... *Tamiasciurus hudsonicus*

Total length more than 450; P3 usually well developed 8

8. Ears having prominent tufts; venter not reddish .... *Sciurus aberti*

Ears lacking prominent tufts; venter usually reddish .... *Sciurus niger*

9. Sides of head striped; posterior border of zygomatic process of maxillary opposite P3 10

Sides of head not striped; posterior border of zygomatic process of maxillary opposite M1 13

10. Dorsal stripes obscure; ground color of dorsum grayish .... *Eutamias dorsalis*

Dorsal stripes prominent; ground color of dorsum brownish 11

11. Size small; condylobasal length less than 30.5; length of hind foot 32 or less .... *Eutamias minimus*

Size large; condylobasal length greater than 31.0; length of hind foot 33 or more 12

12. Dark dorsal stripes brownish and usually three in number; zygomata weak, the jugal narrow in lateral aspect and not flaring dorsally .... *Eutamias umbrinus*

Dark dorsal stripes black and usually five in number; zygomata strong, the jugal broad in lateral aspect, flaring dorsally .... *Eutamias quadrivittatus*

13. Infraorbital foramen narrowly oval, directly above small masseteric tubercle; tail white beneath .... *Ammospermophilus leucurus*

Infraorbital foramen oval, above and lateral to prominent masseteric tubercle; tail various, but not white beneath 14

14. Upper parts spotted, dappled or concolor, not striped 15

Upper parts striped 18

15. Total length more than 350; tail more than 135, broad, distichous; condylobasal length more than 50 16

Total length less than 300, tail less than 100, not notably broad; condylobasal length less than 46 17

16. P3 simple, peglike, less than one-fourth size of P4 .... *Spermophilus variegatus*

P3 bicuspid, more than one-fourth size of P4 .... **Spermophilus franklinii*

17. Upper parts grayish brown, lightly dappled with black and pale buff; hind foot 39 or more .... *Spermophilus richardsonii*

Upper parts reddish brown with prominent black-bordered white spots; hind foot 37 or less .... *Spermophilus spilosoma*

18. Stripes of upper parts narrow, alternating with longitudinal rows of spots .... *Spermophilus tridecemlineatus*

Stripes of upper parts broad, not alternating with longitudinal rows of spots .... *Spermophilus lateralis*

Eutamias dorsalis

Cliff Chipmunk

The cliff chipmunk is known in Colorado only from the rocky, juniper-clad slopes of the O-wi-yu-kuts Plateau and adjacent uplands in western Moffat County, east to Blue Mountain and Cross Mountain. According to Sutton (1954:45), the additional range is from about 5800 to 7000 feet. Warren (1908a) described a collecting trip to Moffat County in March of 1907 expressly to obtain specimens of the cliff chipmunk, and discussed the habitat of the species.

Eutamias dorsalis utahensis Merriam

Eutamias dorsalis utahensis Merriam, Proc. Biol. Soc. Washington, 11:210, 1 July 1897; type locality, Ogden, Weber Co., Utah.

Distribution in Colorado.—Northwestern Moffat County, north of Yampa River and generally west of Little Snake River (Fig. 39).

Measurements.—Mean (and extreme) external measurements of 10 males, followed by those of 15 females, from Moffat County west of Vermillion Creek are: 207.5 (200-213), 214.6 (208-224); 86.4 (81-92), 91.5 (84-98); 33.5 (32-35), 34.5 (33-35); 24.5 (23-26), 24.1 (23-26); weight, 53.97 (49.5-56.3), 55.89 (51.5-65.9). Selected cranial measurements are presented in table 9. For additional measurements, see Sutton (1954).

Records of occurrence.—Specimens examined, 68, distributed as follows: MOFFAT COUNTY: Colorado Highway 318, 8 mi. N junction with Moffat County 10, 1 (CU); *7 mi. N junction highways 318 and 10,* 1 (CU); *6 mi. N junction highways 318 and 10,* 1 (CU); *5 mi. N junction highways 318 and 10,* 5 (CU); *4 mi. N junction highways 318 and 10,* 2 (CU); *3 mi. N junction highways 318 and 10,* 11 (CU); Escalante Hills, 20 mi. SE Ladore, 16 (1 CU, 15 USNM); 2 mi. NW Greystone, 1 (CM); Douglas Spring [3 mi. SE Greystone], 6700 ft., 15 (1 AMNH, 2 CSU, 5 CU, 7 WC); *2 1/2 mi. from Douglas Spring,* 5 (WC); *Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers],* 10 (DMNH); between [Little] Snake River bridge and Lily, 1 (CU).

Additional record: MOFFAT COUNTY: *east of Little Snake River to west flank of Cross Mountain* (Warren, 1942:150).

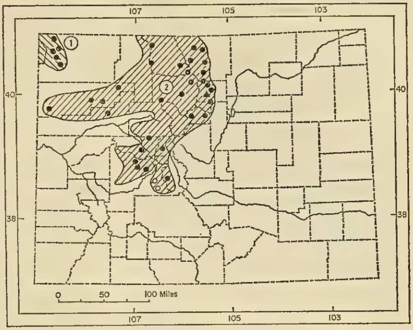


Fig. 39. Distribution of two species of chipmunks in Colorado. 1. *Eutamias dorsalis utahensis.* 2. *Eutamias umbrinus montanus.* For explanation of symbols, see p. 9.

Eutamias minimus

Least Chipmunk

The least chipmunk is the smallest and most abundant sciurid in Colorado, and the species with the widest geographic and ecological range, occurring from semiarid greasewood flats in the San Luis Valley to localities above tree-line in the high mountains. *Eutamias minimus* seemingly is less saxicolous than other Coloradan chipmunks and is not uncommonly encountered in small openings in the mesic forests of middle elevations. It is rarely seen in unbroken forest, however. Where *E. minimus* occurs in sympatry with one of its congeners, it seems invariably to be the more abundant species. The ecology of the least chipmunk has not been studied in detail in Colorado, although Carleton (1966) compared food habits of the least chipmunk and the golden-mantled ground squirrel near Gothic, Gunnison County.

Four subspecies of *E. minimus* are recognized in Colorado; all have the "karyotype A" chromosomal pattern, as defined by Sutton and Nadler (1969). Earlier, Nadler (1964) published karyotypes of *E. m. caryi* and *E. m. consobrinus.* The review of Coloradan chipmunks by Sutton (1953, 1954) contains a particularly useful treatment of *E. minimus* and has been followed to some extent in the accounts of subspecies. White (1953b) reviewed the taxonomy of the least chipmunk in Wyoming, and Conley (1970) studied geographic variation of the species in New Mexico and adjacent Arizona.

Upon superficial examination, Coloradan montane chipmunks are difficult to identify, even when specimens are in hand, unless comparative material is available. Over much of its range in the state, *E. minimus* is sympatric with either *E. quadrivittatus* or *E. umbrinus.* The general resemblance of the species is enhanced by parallel trends in geographic variation in color. *Eutamias minimus consobrinus* parallels the sympatric *Eutamias umbrinus montanus* on the Western Slope, whereas *E. m. operarius* parallels *Eutamias quadrivittatus quadrivittatus* in the east and south. In the southwestern part of the state, specimens assignable to *operarius* are markedly more reddish than those from localities to the north and east, approaching the color of *Eutamias quadrivittatus hopiensis.*

When series of skulls are available, of course, the smaller, lighter skull of *E. minimus* allows ready identification of that species. The baculum of *E. minimus* is narrow at the base and that of *E. umbrinus* is markedly widened. The shaft of the baculum of *E. minimus* is thinner (maximum diameter, less than 0.20) than that of *E. quadrivittatus* (maximum diameter, more than 0.25). Bacula of the species in question were figured by White (1953c).

Eutamias minimus is distinguishable from other Coloradan chipmunks in the field by its shyer and more animated movements, the characteristic vertical orientation of the tail

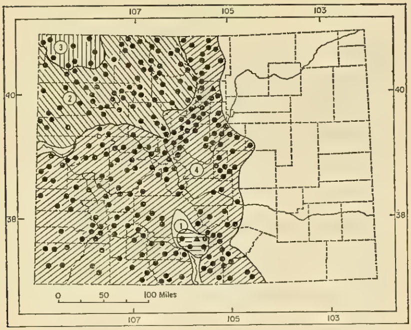


FIG. 40. Distribution of *Eutamias minimus* in Colorado. 1. *E. m. caryi*. 2. *E. m. consobrinus*. 3. *E. m. minimus*. 4. *E.m. operarius*. For explanation of symbols, see p. 9.

when running, and a predilection for more mesic, less rocky habitats than those favored by *E. quadrivittatus*.

Eutamias minimus caryi Merriam

Eutamias minimus caryi Merriam, Proc. Biol. Soc. Washington, 21:143, 9 June 1908; type locality, Medano Ranch, 15 mi. NE Mosca, Alamosa Co., Colorado.

Distribution in Colorado.—Northeastern San Luis Valley (Fig. 40).

Comparisons.—From *E. m. operarius*, the subspecies of the mountains surrounding the San Luis Valley, *E. m. caryi* differs in markedly paler color and smaller external and cranial size. *Eutamias m. caryi* is much paler in color than *E. m. consobrinus*, to which it is similar in size. *E. m. caryi* and *E. m. minimus* are of comparable size and both are pale-colored races of semiarid shrublands.

Measurements.—Mean (and extreme) external measurements of seven males, followed by those of five females, all from the type locality, are: 190.9 (186-200), 196.4 (192-198); 85.9 (83-92), 90.0 (85-96); 30.1 (30-31), 30.2 (29-31). Selected cranial measurements are presented in table 8.

Remarks.—The pale grayish color and obscure dorsal stripes of *E. m. caryi* distinguish the subspecies readily from least chipmunks of the Sangre de Cristo Range. In color, *E. m. caryi* superficially resembles *E. m. minimus* of northwestern Colorado and adjacent areas, and approaches the color of *E. m. cacodemus* of the Badlands of South Dakota. Probably there is no justification, however, for the statement by A. H. Howell (1929:42) that "Cary's chipmunk is closely related to typical *minimus* . . . ," although both subspecies obviously are well adapted to arid to semiarid shrublands. For a description of the habitat of *E. m. caryi*, see Warren (1910a).

Eutamias m. caryi is adapted to life on stabilized dune sands and on the pale, alkaline soils of the extensive stands of *Sarcobatus* in the northeastern San Luis Valley. In part, the range of the subspecies is isolated from that of *E. m. operarius* by the sterile sands comprising Great Sand Dunes National Monument. Both north and south of the sand dunes, intergradation with *operarius* occurs, as indicated by specimens from the mouth of Mosca Creek and from Crestone. According to A. H. Howell (1929:42), "intergradation with *operarius* is indicated by specimens from the mouth of Mosca Pass, at 8200 feet altitude." This is a *lapsus* and should read "mouth of Mosca Creek." Mosca Creek is confluent with Medano Creek at about 8200 feet; Mosca Pass, on the other hand, is in the Sangre de Cristo Range at the head of Mosca Creek, at an elevation of 9713 feet. Animals from that elevation in the Sangre de Cristos are referable to *operarius*.

Specimens from the San Luis Valley south of Sierra Blanca (labelled San Acacio, Fort Garland, Fort Massachusetts, N of Trinchera Peak, NE of Chama) are paler in color than is usual for specimens of *operarius*, but are referred to that subspecies on the basis of large size.

Records of occurrence.—Specimens examined, 62, distributed as follows: ALAMOSA COUNTY: 9 mi. E Center, 2 (KU); mouth of Mosca Creek, 2 (WC); *San Luis Lake*, 2 (WC); Medano Ranch, 15 mi. NE Mosca, 24 (1 CU, 12 USNM, 11 WC); Mosca, 8 (6 DMNH, 2 WC); *22 mi. E Mosca*, 2 (AMNH); *Great Sand Dunes National Monument*, 10 (CU); *Montville Trail*, 1 (GSDNM); *San Luis Valley, S of Sand Dunes*, 1 (DMNH); *6 mi. S, 3 mi. W Great Sand Dunes National Monument*, 2 (KU); 2 mi. S Great Sand Dunes National Monument, 8 (KU).

Eutamias minimus consobrinus (J. A. Allen)

Tamias minimus consobrinus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 3:112, June 1890; type lo-

TABLE 8

Selected cranial measurements of four subspecies of *Eutamias minimus*.
(Measurements as defined by White, 1953a.)

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Interorbital constriction	Length of nasals	Length of mandibular toothrow	Condyloalveolar length of mandible
Eutamias minimus caryi, Medano Ranch, 15 mi. NE Mosca, Alamosa County							
Mean, 7 ♂	30.03	27.64	16.99	6.40	8.93	5.31	15.83
Minimum	29.8	27.2	16.5	5.9	8.8	5.1	15.2
Maximum	30.9	28.4	17.3	7.1	9.2	5.4	16.2
Mean, 5 ♀	30.00	27.86	16.80	6.44	8.86	5.34	15.88
Minimum	29.0	27.5	16.6	6.2	8.7	5.1	15.0
Maximum	31.0	28.6	17.1	6.8	9.0	5.4	15.9
Eutamias minimus consobrinus, White River Plateau							
Mean, 5 ♂	30.58	27.74	16.68	6.57	9.16	5.00	16.02
Minimum	30.2	27.7	16.1	6.3	8.6	4.8	16.0
Maximum	31.3	28.9	17.4	6.8	9.6	5.2	16.6
Mean, 5 ♀	31.10	28.25	17.40	7.10	9.32	4.95	16.53
Minimum	30.7	27.6	17.2	7.0	8.9	4.9	16.4
Maximum	31.6	28.6	17.7	7.2	9.9	5.0	16.8
2 mi. N, 2 mi. W Gould, 8600 ft., Jackson County							
Mean, 6 ♂	30.67	28.40	17.22	6.65	9.18	5.00	15.93
Minimum	30.0	28.0	16.8	6.4	9.0	4.8	15.5
Maximum	31.5	29.5	17.6	7.1	9.4	5.2	16.4
Mean, 10 ♀	31.00	28.85	17.44	6.66	9.25	5.02	16.30
Minimum	30.5	28.4	16.9	6.4	8.5	4.7	15.8
Maximum	31.7	29.4	18.0	6.9	9.7	5.2	16.9
Eutamias minimus minimus, north-central Moffat County							
WC 2350, ♂	29.7	27.2	16.8	6.5	8.9	5.0	15.4
WC 2371, ♂	30.7	27.8	16.6	6.5	9.0	5.0	15.8
WC 2326, ♀	29.7	28.1	17.1	7.1	8.5	4.8	15.4
WC 2373, ♀	29.7	27.5	16.9	7.4	8.0	5.1	15.3
Eutamias minimus operarius, Boulder County							
Mean, 4 ♀	32.20	29.37	17.60	7.20	9.88	4.88	17.00
Minimum	31.9	29.2	17.2	6.9	9.6	4.6	16.4
Maximum	32.7	29.5	17.9	7.6	10.4	5.1	18.0
Grand Mesa, Mesa and Delta counties							
Mean, 16 ♂	31.48	28.76	17.69	6.89	9.58	4.46	16.65
Minimum	31.0	28.4	17.2	6.5	9.1	4.4	16.4
Maximum	31.7	29.8	18.2	7.6	10.3	4.8	17.2
Mean, 11 ♀	31.85	29.18	18.01	6.87	9.56	4.73	16.71
Minimum	31.3	28.6	17.8	6.4	9.1	4.6	16.0
Maximum	32.7	29.9	18.4	7.1	10.2	4.9	17.4
vicinity of Cochetopa Hills, Chaffee and Saguache counties							
Mean, 6 ♂	31.48	28.40	17.43	6.72	—	4.70	16.52
Minimum	30.9	27.8	16.6	6.5	—	4.5	16.2
Maximum	31.6	29.8	18.2	7.2	—	5.0	17.0

Table 8 (Continued)
Selected cranial measurements of four subspecies of *Eutamias minimus*.
(Measurements as defined by White, 1953a.)

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Interorbital constriction	Length of nasals	Length of mandibular toothrow	Condyloalveolar length of mandible
vicinity of Cochetopa Hills, Chaffee and Saguache counties							
Mean, 10 ♀	31.58	28.68	17.72	6.86	9.68	4.80	16.57
Minimum	31.1	28.5	17.0	6.6	9.3	4.5	16.2
Maximum	32.2	29.5	18.1	7.4	9.9	5.0	17.0
western Conejos County							
Mean, 7 ♂	31.99	29.29	17.74	6.83	9.70	5.13	16.71
Minimum	31.5	28.8	17.5	6.3	9.2	4.6	16.4
Maximum	32.4	29.8	18.0	7.4	10.1	5.5	17.0
Mean, 7 ♀	32.70	30.02	18.20	7.00	9.73	5.16	17.06
Minimum	32.4	29.6	17.6	6.2	9.5	4.8	16.7
Maximum	33.0	30.4	18.7	7.8	10.2	5.5	17.4

cality, near Barclay, Parley's Canyon, Wasatch Mountains, Salt Lake Co., Utah.

Eutamias minimus consobrinus, Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30(1):42, 27 December 1901.

Distribution in Colorado.—Northwestern part of state, south of Yampa River and north of Book Cliffs (Fig. 40).

Comparisons.—For comparisons with *E. m. caryi* and *E. m. minimus*, see accounts of those subspecies. From *E. m. operarius*, the subspecies to the east and south, *E. m. consobrinus* differs in smaller external and cranial size and in generally darker, less reddish, color.

Measurements.—Mean (and extreme) external measurements of five males, followed by those of 10 females, all from 2 mi. N and 2 mi. W of Gould, 8600 ft., Jackson County, are: 190.8 (188-195), 200.3 (191-205); 79.8 (75-88), 86.8 (80-90); 29.2 (28-30), 29.9 (29-31); 16.4 (16-17), 16.4 (15-18); mean weight of six males, 40.27 (38.7-40.7), of six females, 44.42 (36.8-50.0). Representative cranial measurements are given in table 8.

Remarks.—A. H. Howell (1929:47) referred specimens from Gunnison and Delta counties to *E. m. consobrinus*. The far more abundant material now available from western Colorado has convinced me, however, that *consobrinus* is restricted in the state to the area north of the Colorado River, except in the area of the headwaters of that stream in Eagle and Grand counties. There broad intergradation with *E. m. operarius* occurs. A series of specimens from the Grand Mesa was referred by Anderson (1959a:410) to *consobrinus*, but in large size and bright color these specimens more closely resemble *E. m. operarius* as understood by me, and are herein referred to the latter subspecies.

Intergradation between *consobrinus* and *operarius* occurs along the Medicine Bow Range and in the upper Laramie River Valley in Larimer County, at the headwaters of the Colorado River in eastern and southern Grand County, in the Gore Range of eastern Eagle County, and in Pitkin and Lake counties. Distinctions between the two subspecies are difficult to apply in these areas, and the line between them on the map, Fig. 40, is arbitrary in roughly following the Continental Divide between Milner Pass and Tennessee Pass.

Durrant (1952:141) referred specimens from Uintah County, Utah, to *E. m. operarius* and noted that the Colorado and Green rivers form a barrier to dispersal of that subspecies. By an extension of that view (see Durrant, *op. cit.*:133, map) to Colorado, one would expect chipmunks from the Roan and White River plateaus to be referable to *operarius*, which I have not found to be the case, referring them here to *consobrinus*. Apparently the broad, low Grand Valley of the Colorado and the barren rampart of the Cathedral Bluffs and Book Cliffs are the important barriers separating the subspecies in Colorado.

Remarks on intergradation between *E. m. consobrinus* and *E. m. minimus* are made in the account of the latter subspecies.

A young adult specimen from Hot Sulphur Springs, Grand County (CSU 12000), is completely melanistic, except for a small patch of white hairs in the gular region. This evidently is the specimen reported by Gilbert and Gilbert (1970).

Records of occurrence.—Specimens examined, 615, distributed as follows: MOFFAT COUNTY: Pot Creek, near Pat's Hole, 1 (DMNH); 8 mi. NE Craig, 9 (CM); 5 mi. W Craig, 2 (CM); *Craig, 6100 ft.*, 4 (WC); *Round Top Mountain, Dinosaur National Monument*, 2 (CU); *18 mi. NE Artesia [Dinosaur]*, 1 (CU); *S bank Yampa River, 5 mi. NW Cross Mountain*, 2 (1 AMNH, 1 CM); 1 mi. SE Cross Mountain, 15 (9 AMNH, 6 CM); *2 mi. SE Cross Mountain*, 2 (CM); *5 mi. SE Cross Mountain*, 3 (CM); *6 mi. SW Cross Mountain*, 3 (CM); 2 mi. E Hamilton, 1 (CU); 1 mi. E Elk Springs, 7 (CM); Axial Basin, 2 (USNM); Coyote Basin, 6300 ft., 1 (WC). ROUTT COUNTY: Three Forks, 30 mi. above Baggs, Wyoming, 12 (AMNH); *14 mi. E Slater, 7050 ft.*, 1 (CU); 2 mi. N Columbine, 8425 ft., 1 (CU); *Columbine, 8800 ft.*, 8 (CU); *4 mi. NE Hahn's Peak*, 1 (CSU); *49 1/2 mi. [by road] N Hayden, 8000 ft.*, 1 (CU); 43 mi. [by road] N Hayden, 8225 ft., 1 (CU); *42 mi. [by road] N Hayden*, 1 (CU); *41 mi. [by road] N Hayden, 8300 ft.*, 1 (CU); *36 mi. [by road] N Hayden, 8175 ft.*, 2 (CU); *Elkhead Mountains, 20 mi. SE Slater*, 1 (USNM); *22 mi. SE Slater*, 3 (CU); *23 mi. SE Slater, 7550 ft.*, 1 (CU); *23 1/2 mi. SE Slater, 7600 ft.*, 1 (CU); Hahn's Peak, 1 (USNM); 27 mi. [by road] N Hayden, 8300 ft., 13 (CU); Steamboat Springs, 6750 ft., 4 (1 AMNH, 3 WC); 18 mi. below Steamboat Springs, 3 (WC); *Rabbit Ears Peak, 9200 ft.*, 3 (CU); 8 mi. W Rabbit Ears Pass, 9400 ft., 1 (CU); Rabbit Ears Pass, 9680 ft., 1 (CM); Oak Creek, 1 (WC); Yampa, 2 (WC); *Wright's Ranch, near Yampa, 7700 ft.*, 1 (AMNH); *near Egeria Pass, 8000 ft.*, 2 (WC); 9 mi. NW Yampa, 6 (KU); *Middle Stillwater Creek, Dome Peak*, 6 (DMNH); *Dome Peak*, 2 (DMNH); 3 1/2 mi. S Toponas, 8750 ft., 4 (CU); *1 mi. from Cedar Springs* (not found), 1 (WC); *3 mi. from Cedar Springs* (not found), 1 (WC). JACKSON COUNTY: Pearl, 1 (USNM); *near Pearl*, 2 (1 CSU, 1 CU); Mount Zirkel, 2 (1 DMNH, 1 WC); *Baldy Mountain, 9825 ft.*, 1 (WC); *Canadian Creek*, 4 (USNM); 5 mi. E Canadian Creek, 3 (USNM); Delaney Butte, 1 (CSU); *Hell Creek*, 1 (WC); *16 mi. N Hebron, 9000 ft.*, 1 (CU); *2 mi. N, 9 1/2 mi. W Walden, 8400 ft.*, 1 (KU); *13 1/4 mi. W Walden*, 1 (CU); *10 mi. W Walden*, 1 (CSU); Walden, 7 (DMNH); *2 mi. N, 12 mi. W Hebron*, 3 (CU); *1 mi. N, 12 mi. W Hebron, 8750 ft.*, 2 (CU); *16 mi. W Hebron*, 2 (CU); *15 mi. W Hebron, 8800 ft.*, 1 (CU); *14 mi. W Hebron, 8775 ft.*, 2 (CU); *13 1/2 mi. W Hebron*, 2 (CU); *13 1/4 mi. W Hebron, 8750 ft.*, 2 (CU); *13 mi. W Hebron, 8675 ft.*, 3 (CU); Buffalo Pass Road, 10,530 ft., 3 (WC); *5 mi. N, 4 mi. W Gould, 8600 ft.*, 1 (KU); 2 mi. N, 2 mi. W Gould, 8600 ft., 18 (KU); *3 mi. below Cameron Pass*, 1 (WC); *Homestead Ranch*, 8 (DMNH); Spicer, 1 (DMNH); Arapaho Pass, 8 (1 CU, 7 USNM); *North Park*, 1 (USNM). RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 5600 ft., 1 (USNM); 12 mi. SW Hamilton, 1 (CU); 12 mi. SW Oak Creek, 8300 ft., 10 (CU); *12 1/2 mi. SW Oak Creek*, 1 (CU); 7 mi. S Price Creek, 7085 ft., 1 (CU); *15 mi. S Price Creek*, 1 (CU); 15 mi. S Willow Creek, 9175 ft., 6 (CU); *16 mi. S Willow Creek, 9300 ft.*, 1 (CU); *5 mi. S Pagoda Peak, 9100 ft.*, 8 (KU); *22 mi. S Willow Creek, 8900 ft.*, 1 (CU); 5 mi. W Rangely, 5600 ft., 1 (USNM); Lost Creek, 9 mi. NE Buford, 3 (CM); *6 mi. NE Meeker*, 6 (CM); *N side White River, 4 mi. W Meeker*, 2 (CM); Meeker, 6200 ft., 15 (3 AMNH, 4 USNM, 8 WC); Big Beaver Creek, 6800 ft., 5 (1 AMNH, 4 WC); Ute Creek, 8000 ft., 8 (AMNH); *Dry Fork, White River, 6200 ft.*, 3 (AMNH); *Dry Fork, White River, 6300 ft.*, 3 (AMNH); *Dry Fork, White River, 6500 ft.*, 1 (AMNH); Marvine, 1 (USNM); *Marvine Lodge*, 2 (CU); *8 mi. SE South Fork Campground, White River National Forest*, 2 (CSU); *Grand Hogback, 5 mi. S Meeker*, 3 (CM); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 8 (CM); Hill Creek, 10 mi. above Buford, 1 (UMMZ); 13 mi. NW Rio Blanco, 6800 ft., 1 (CU); *10 1/2 mi. NW Rio Blanco, 7000 ft.*, 1 (CU); White River Plateau, 25 mi. SE Meeker, 5 (USNM); Mud Springs, 8850 ft., 6 (1 AMNH, 5 WC); *Three Forks*, 3 (FMNH); *White River Plateau*, 3 (USNM); West Fork Douglas Creek, 35 mi. S Rangely, 8000 ft., 27 (CM); *5 mi. NW Rio Blanco*, 1 (CU); Rio Blanco, 1 (USNM); *32 mi. S Rangely, 6800 ft.*, 1 (CU); Roan Plateau, 6300 ft., 5 mi. SE Dragon, Utah, 1 (USNM); Roan Plateau, 7000 ft., 14 mi. SE Dragon, Utah, 1 (USNM); *Compass Creek, 9000 ft.* (not found), 15 (AMNH). GARFIELD COUNTY: *1 mi. NW Trappers Lake*, 2 (CM); Trappers Lake, 1 (CSC); Deep Lake, 16 mi. N Glenwood Springs, 1 (KU); 18 mi. S Buford, 2 (CU); 35 mi. N Loma, 8010 ft., 1 (CU); *Baxter Pass, 28 mi. N, 5 mi. W Mack, 7250 ft.*, 5 (KU); *32 mi. N Loma, 7225 ft.*, 4 (CU); *30 mi. N Loma, 7400 ft.*, 1 (CU); 1/2 mi. N Douglas Pass, 8050 ft., 1 (CU); 20 mi. N Mack, 2 (CM); head Douglas Creek, [about] 30 mi. S Rangely, 7700 ft., 3 (CM). EAGLE COUNTY: Yarmany Creek, near McCoy, 1 (WC); 20 mi. SW Toponas, 3 (DMNH); Allenton, 7200 ft., 9 (2 AMNH, 1 CSU, 6 WC); Eagle, 4 (3 CU, 1 WC); *3 mi. below Eagle*, 1 (WC); *Gypsum*, 2 (USNM); Minturn, 7950 ft., 4 (CU); *4 mi. W Vail Pass, 9700 ft.*, 4 (CU); Red Cliff, 8608 ft., 1 (WC); between Pando and Mitchell, 9700 ft., 1 (WC). GRAND COUNTY: *1 mi. E Rabbit Ears Pass, 9050 ft.*, 1 (CU); Mount

Whitely, 3 (USNM); Shipler Park, 1 (RMNP); Lulu City, 1 (RMNP); Milner Pass, 10,000 ft., 2 (KU); 6 mi. N Grand Lake, 2 (FMNH); 28 mi. NW Granby, 9200 ft., 6 (CU); *17 mi. NW Granby, 9000 ft.,* 1 (CU); *10 mi. NW Granby, 8600 ft.,* 2 (CU); *20 mi. N Kremmling,* 1 (CU); 12 mi. N Kremmling, 1 (USNM); *9 1/2 mi. N Kremmling,* 1 (CU); Grand Lake, 3 (1 AMNH, 2 WC); *Shadow Mountain Reservoir,* 1 (RMNP); *3 mi. S, 2 mi. E Grand Lake, 8375 ft.,* 27 (UNM); Hot Sulphur Springs, 7665 ft., 22 (3 AMNH, 3 CSU, 3 USNM, 13 WC); Kremmling, 2 (WC); *Coulter,* 5 (USNM); Fraser, 1 (KU); McCoy Road, near St. Paul Coppermine, 1 (WC); Sheephorn Pass, 8200 ft., 1 (AMNH); *near Sheephorn Pass, 8200 ft.,* 8 (1 AMNH, 7 WC); Berthoud Pass, 2 (USNM).

Additional records: JACKSON COUNTY: *[near] Lake Agnes* (Yeager, 1950:329). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53).

Eutamias minimus minimus (Bachman)

Tamias minimus Bachman, Jour. Acad. Nat. Sci. Philadelphia, 8:71, 1839; type locality, Green River, near mouth of Big Sandy Creek, Sweetwater Co., Wyoming.

Eutamias minimus, Miller and Rehn, Proc. Boston Soc. Nat. Hist., 30(1):42, 27 December 1901.

Distribution in Colorado.—Northern Moffat County, north of Yampa River, east of Green River, and west of Fortification Creek (Fig. 40).

Comparisons.—From *E. m. consobrinus,* geographically adjacent to the south and east in Colorado, *E. m. minimus* differs primarily in markedly paler color. *Eutamias m. minimus* is similar in color and size to *E. m. caryi,* but is paler in color and smaller both externally and cranially than *E. m. operarius.*

Measurements.—External measurements of three males and two females from north-central Moffat County are: 188, 183, 187, 190, 187; 87, 80, 85, 83, 83, 84; 30, 30, 30, 30, 30. Cranial measurements are presented in table 8.

Remarks.—The range of *E. m. minimus* apparently does not meet that of *E. m. operarius* in Colorado, although White (1953b:598) has demonstrated intergradation between *operarius* and *minimus* in southern Wyoming. Intergradation between *E. m. minimus* and *E. m. consobrinus* is apparent in central and southern Moffat County, in a broad band along the Yampa River from its confluence with the Green River eastward to the vicinity of Craig. The two subspecies differ little in size and individual specimens intermediate in color between the two are difficult or impossible to assign to subspecies with any confidence. Obvious intergrades between the two subspecies were examined from Lily, Snake River, 8 mi. NE of Craig, Craig, and 1 mi. E of Elk Springs. Specimens from the latter three localities are referred to *consobrinus* on the basis of characteristics of a majority of specimens from those localities.

The Coloradan range of *E. m. minimus* was distorted in the distribution map presented by Hall and Kelson (1959:301). Those authors listed as marginal a record of *minimus* from "Sand Creek," attributed to Warren (1942:144). Describing the range of *minimus,* Warren (*loc. cit.*) wrote that it was ". . . confined to the northwestern corner of the State, its eastern limit being roughly about 20 miles east of the Snake River . . . , and its southern [limit] by the Bear [Yampa] River at Sand Creek and Lily." A. H. Howell (1929:38) mentioned a specimen from "Bear River (at Sand Creek), Routt County." Evidently Hall and Kelson *(loc. cit.)* correctly equated the two citations mentioned, but plotted Sand Creek in present-day Routt County. In fact, the Sand Creek in question is in Moffat County, some 60 air-miles to the west of the locality plotted. Moffat County was part of Routt County until 1911.

Records of occurrence.—Specimens examined, 35, distributed as follows: MOFFAT COUNTY: Snake River, 20 mi. W Baggs, Wyoming, 1 (USNM); *1 1/2 mi. S junction Sparks Road and Colorado Highway 318, 7300 ft.,* 1 (CU); Sparks, 1 (CU); Ladore, 1 (USNM); [Little] Snake River, S of Sunny Peak, 2 (USNM); 7 mi. W Great Divide, 7100 ft., 2 (CU); *9 mi. SW Great Divide, 7225 ft.,* 1 (CU); *Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers],* 4 (DMNH); *5 mi. NE Greystone, 6500 ft.,* 1 (CU); 3 mi. W Greystone, 6350 ft., 1 (CU); *Douglas Spring [3 mi. SE Greystone],* 1 (WC); [Little] Snake River, lower bridge, 5860 ft., 6 (1 AMNH, 5 WC); Bear [Yampa] River at Sand Creek, 1 (WC); Lay, 4 (1 CSU, 1 USNM, 2 WC); *1 mi. E Lay, 6450 ft.,* 1 (WC); Lily, 1 (DMNH); *"Lily, Elk Springs,"* 1 (USNM); *Snake River,* 4 (DMNH).

Eutamias minimus operarius Merriam

Eutamias amoenus operarius Merriam, Proc. Biol. Soc. Washington, 18:164, 29 June 1905; type locality, Gold Hill, 7400 ft., Boulder Co., Colorado.

Eutamias minimus operarius, A. H. Howell, Jour. Mamm., 3:183, 4 August 1922.

Distribution in Colorado.—Foothills and mountains of Eastern Slope (except North Platte drainage); south-central and southwestern parts of state, north to Colorado River (Fig. 40).

Comparisons.—For comparison with other Coloradan races, see accounts of those subspecies.

Measurements.—Average (and extreme) external measurements of four females from Boulder County are: 203.0 (200-208), 86.0 (79-93), 31.7 (31-33), 16.3 (15-18). Average (and extreme) external measurements of six males, followed by those of six females, from Conejos and Costilla counties, are: 207.6 (202-213), 205.8 (196-218); 95.2 (91-100), 91.5 (79-98); 30.7 (29-32), 31.0 (29-32); 16.8 (14-20), 15.3 (13-19). Mean (and extreme) external measurements of 16 males, followed by those of 11 females, from the Grand Mesa, are: 201.2 (192-209), 202.9 (187-215); 89.1 (82-98), 89.3 (74-96); 30.0 (27-32), 30.0 (28-32); 16.3 (14-18), 16.4 (15-18); weight, 41.23 (37.7-44.0), 50.95 (44.4-61.8). Representative cranial measurements are presented in table 8.

Remarks.—Intergradation with *E. m. consobrinus* and *E. m. caryi* is discussed in the accounts of those subspecies. The range of *E. m. operarius* apparently does not meet that of *E. m. minimus* in Colorado. White (1953b: 598) regarded specimens from Carbon and Albany counties, Wyoming, as intergrades between those two kinds.

Specimens listed by A. H. Howell (1929: 49) from Berthoud probably are, in fact, from Berthoud Pass.

Records of occurrence.—Specimens examined, 1251, distributed as follows: LARIMER COUNTY: 3 mi [S]E Mountain Home, Wyoming, 1 (CU); *Laramie River at state line, 8200 ft.*, 1 (CU); *Laramie River, 6 mi. S state line*, 1 (CU); *1 mi. W Virginia Dale*, 1 (CSC); Virginia Dale, 2 (CSU); 9 mi. NE Glendevy, 8700 ft., 1 (CSU); *North Fork Campground, Roosevelt National Forest*, 1 (CSU); *21 mi. NW Fort Collins*, 1 (CSU); *Red Feather Lakes*, 1 (UI); *Dowdy Lake, 8250 ft.*, 7 (CU); *sec. 35, T. 10 N, R. 73 W*, 1 (CSU); *7 mi. W Livermore, 7810 ft.*, 7 (CU); Livermore, 1 (USNM); *14 mi. N Fort Collins*, 1 (CSU); *2 mi. E Log Cabin*, 1 (CSU); Elkhorn, 2 (USNM); *3 mi. E Elkhorn*, 1 (WC); *Laramie River, 26 mi. S state line, 8700 ft.*, 1 (CU); *12 mi. NW Fort Collins*, 1 (CSU); *4 mi. N Chambers Lake*, 1 (CU); *Rawah Wild Area, 10,000 ft.*, 1 (CSU); *Rawah Lake No. 3, 10,500 ft.*, 1 (CSU); *4 mi. N, 12 mi. W Fort Collins, 7400 ft.*, 3 (CSU); *3 1/2 mi. N, 12 1/2 mi. W Fort Collins*, 1 (CSU); *40 mi. W Fort Collins*, 1 (CSU); *38 mi. W Fort Collins*, 1 (CSU); Chambers Lake, 4 (1 CU, 3 WC); *Crown Point, 11,400 ft.*, 1 (CSU); Pingree Park, 1 (CSU); *sec. 15, T. 7 N, R. 73 W, 8000 ft.*, 1 (CSU); *SW 1/4 sec. 15, T. 7 N, R. 73 W, 8600 ft.*, 1 (CSU); 3 3/4 mi. SW Fort Collins, 1 (CSU); *Spring Canyon Dam, 5000 ft.*, 1 (CSU); *14 mi. NW Estes Park*, 1 (RMNP); *13 mi. NW Estes Park*, 1 (RMNP); *12 mi. NW Estes Park*, 1 (RMNP); Devil's Gulch, 1 (CSU); *2 mi. N Chasm Falls*, 2 (RMNP); Estes Park, 7600 ft., 46 (1 CSU, 1 CU, 3 KU, 3 MCZ, 38 USNM); *Hallowell Park*, 2 (RMNP); *2 1/2 mi. SW Estes Park*, 12 (KU); *3 1/2 mi. SW Estes Park*, 1 (KU); *4 1/2 mi. SW Estes Park*, 13 (KU); *3 mi. S, 3 mi. W Estes Park*, 1 (UI); *4 mi. S, 2 mi. W Estes Park, 8000 ft.*, 1 (KU); *4 mi. S Estes Park, 8000 ft.*, 1 (KU); *8 mi. N Allenspark*, 2 (CU); *Longs Peak Ranger Station*, 2 (RMNP); Longs Peak, 9 (USNM); *Longs Peak, above timberline*, 4 (USNM). GARFIELD COUNTY: *25 mi. NE Collbran, 7300 ft.*, 1 (CU); Middle Mamm Creek, near Rifle, 30 (DMNH); 12 mi. SE Rifle, 1 (FMNH). EAGLE COUNTY: *5 mi. N Colorado Highway 82 on Colorado Highway 333, 7380 ft.*, 3 (CU); *4 mi. N Highway 82 on Highway 333, 7220 ft.*, 6 (CU); 2 mi. N Highway 82 on Highway 333, 6925 ft., 1 (CU). SUMMIT COUNTY: Gore Range, 1 (DMNH); Dillon, 1 (CSU); *Loveland Pass*, 1 (KU); Gray's Peak, 16 (KU); Breckenridge, 9524 ft., 1 (WC); *near Boreas Pass*, 1 (WC); *Boreas Pass, 11,470 ft.*, 5 (2 AMNH, 3 WC); *Hoosier Pass*, 4 (DMNH); *3 mi. below Kokomo, 10,640 ft.*, 2 (WC); Kokomo, 1 (WC). BOULDER COUNTY: *Mount Meeker, 8700 ft.*, 1 (AMNH); *3/4 mi. N, 2 mi. W Allenspark*, 1 (KU); *2 mi. N Raymond*, 1 (RMNP); *2 3/10 mi. W mouth James Creek, 7000 ft.*, 2 (CU); Mount Audubon, 1 (CU); *Wild Basin Ranger Station, 8350 ft.*, 1 (CU); *1 mi. NE Ward, 10,000 ft.*, 1 (KU); *6 mi. W Ward*, 1 (CU); *Boulder Canyon*, 2 (CU); *Brainard Lake*, 2 (CU); *Ward*, 7 (USNM); *near Ward*, 1 (CU); *2 mi. E Colorado Highway 160 on Gold Hill Road*, 1 (CU); *5 mi. W Gold Hill*, 1 (KU); *2 mi. W Gold Hill, 9000 ft.*, 4 (KU); Gold Hill, 14 (USNM); *1 mi. S Gold Hill, 8200 ft.*, 6 (KU); *Niwot Ridge, 11,000 ft.*, 1 (CU); *below Niwot Ridge*, 1 (FMNH); *head of Fourmile Creek, 10,200 ft.*, 1 (UI); *Science Lodge*, 8 (CU); *1/4 mi. E Science Lodge, 9500 ft.*, 1 (UI); *1/2 mi. W Mount Alto Park, 8500 ft.*, 1 (CU); *3 mi. S Ward, 9000 ft.*, 2 (KU); *4 mi. SE Ward*, 5 (RMNP); *3 mi. S, 1/2 mi. E Ward, 9400 ft.*, 4 (KU); *5 mi. W Boulder*, 1 (USNM); *5 mi. S Ward*, 1 (CU); Boulder, 14 (3 ANSP, 1 CU, 7 FMNH, 3 USNM); 7 mi. NW Eldora, 5 (CU); *foot of Flagstaff Road*, 1 (CU); *Gregory Canyon*, 4 (2 CU, 1 FWS, 1 UNM); *8 mi. NW Nederland*, 3 (CU); *7 mi. NW Nederland*, 1 (UMMZ); *Rainbow Lake Campground, Roosevelt National Forest*, 1 (CU); *Nederland*, 3 (1 ANSP, 1 CU, 1 USNM); *Dixie Lake*, 1 (DMNH); 3 mi. E Pinecliff, 1 (DMNH); *no locality other than county*, 9 (3 DMNH, 6 USNM). GILPIN COUNTY: *6 mi. S Nederland*, 1 (CU); Moon Gulch, SW of Rollinsville, 1 (CU); *Lump Gulch*, 1 (CU); Blackhawk, 1

(USNM). CLEAR CREEK COUNTY: near Idaho [Springs], 1 (USNM); *Mill City,* 1 (AMNH); *Floyd Hill, 5 mi. E Idaho Springs, 7800 ft.,* 1 (USNM); *Camp Lemon, above Silverplume,* 1 (DMNH); Silverplume, 7 (DMNH); *20 mi. W Evergreen, 8500 ft.,* 1 (CSU); *Echo Lake,* 1 (UI); Mount Evans, 7 (CU). JEFFERSON COUNTY: *4 mi. W Golden,* 3 (1 CSU, 1 DMNH, 1 WC); *2 mi. W Golden,* 1 (CSU); Golden, 6500 ft., 6 (1 DMNH, 4 KU, 1 USNM); *Mount Vernon Canyon,* 5 (2 FWS, 3 KU); Evergreen, 1 (DMNH); Turkey Creek, 1 (DMNH); 3 mi. above Littleton, 5374 ft., 1 (WC); Dawson Station, 1 (CSU); Pine, 1 (UI); South Platte, 1 (CU); *Wellington Lake,* 1 (MCZ); *no locality other than county,* 2 (DMNH). MESA COUNTY: 10 mi. S Colorado Highway 330 on Ragged Mountain Road, 3 (CU); Collbran, 1 (CU); *4 mi. S, 3 mi. E Collbran, 6800 ft.,* 3 (KU); *9 mi. S, 3 mi. E Collbran, 6800 ft.,* 7 (KU); *Trickle Park Campground, Grand Mesa National Forest,* 4 (UI); 1/4 mi. W Colorado National Monument, 6600 ft., 1 (CU); *sec. 29, T. 11 S, R. 95 W,* 2 (KU); *Land's End,* 1 (WC); *Wild Rose Campground, Grand Mesa National Forest,* 1 (CU); Grand Mesa, 1 (FMNH); Land's End Road, near Whitewater, 4 (CU); *near Whitewater, 8000 ft.,* 1 (CU); *Glade Park,* 2 (FMNH); 10 mi. SW Whitewater, 7500 ft., 1 (CU); *8 mi. S Glade Park P. O.,* 2 (CU); *14 mi. S Glade Park P. O.,* 2 (CU); 5 mi. W Unaweep Canyon, Uncompahgre Plateau, 2 (USNM); *Uncompahgre Plateau,* 2 (CU); Piñon Mesa, 7000 ft., 4 (FMNH); 15 mi. E Gateway, 7 (KU). PITKIN COUNTY: Aspen, 2 (DMNH); 11 mi. E Aspen, 3 (CU); *12 mi. E Aspen, 10,600 ft.,* 3 (CU); *Hunters Creek, near Aspen,* 3 (DMNH); Redstone, 1 (DMNH); *2 mi. SW Aspen, 8175 ft.,* 1 (CU); 9 mi. SW Aspen, 9600 ft., 3 (CU); *5 mi. W Independence Pass, 11,000 ft.,* 2 (FMNH); *Independence Pass,* 1 (FMNH); 19 mi. SE Aspen, 11,110 ft., 1 (CU); *Elk Mountains,* 1 (USNM). LAKE COUNTY: between Tennessee Pass and Leadville, 10,200 ft., 4 (WC); *Halfmoon Creek, 8 mi. SW Leadville, 10,000 ft.,* 8 (KU); *Halfmoon Creek, 9 mi. SW Leadville, 11,000 ft.,* 4 (KU); *"9 to 11 mi. SW Leadville,"* 2 (KU); *Halfmoon Creek, 11 mi. SW Leadville, 12,000 ft.,* 7 (KU); *13 mi. SW Leadville, about 13,500 ft.,* 6 (KU); 16 mi. W U.S. Highway 24 on Colorado Highway 82, 10,100 ft., 2 (CU); *15 mi. W U.S. Highway 24 on Colorado Highway 82, 10,190 ft.,* 2 (CU). PARK COUNTY: 11 mi. N Grant, 10,150 ft., 1 (CU); *8 mi. NNW Grant, 10,000 ft.,* 4 (FWS); *4 1/2 mi. N Grant,* 1 (CU); Grant, 1 (CU); *1 mi. E Grant, 8375 ft.,* 1 (CU); *Call [Hall] Valley,* 5 (DMNH); 5 mi. W Webster, 2 (DMNH); *Webster,* 2 (DMNH); Mount Lincoln, 11,000 ft., 1 (WC); *Montgomery,* 6 (1 AMNH, 5 MCZ); *Mount Bross, 10,500 ft.,* 1 (USNM); *4 mi. W Alma,* 8 (7 FMNH, 1 UI); Bailey, 1 (KU); *2 1/2 mi. S Estabrook,* 5 (FHSC); *Michigan Creek, 6 mi. below Jefferson, 9050 ft.,* 3 (1 AMNH, 2 WC); Como, 9800 ft., 2 (USNM); Mosquito Gulch, 10,500 ft., 2 (WC); *Beaver Creek, 3 mi. above Fairplay,* 4 (WC); *2 1/2 mi. W Fairplay, 10,200 ft.,* 4 (UI); Fairplay, 1 (MCZ); *Sacramento Gulch,* 3 (DMNH); *Ptarmigan Peak,* 2 (DMNH); Tarryall Creek, 6 mi. above Puma City, 1 (WC); 16 mi. W U.S. Highway 285 on Colorado Highway 310, 10,700 ft., 3 (CU); *Dudley* (not found), 1 (DMNH); *no locality other than county,* 1 (DMNH). DOUGLAS COUNTY: Sedalia, 1 (CU); Castle Rock, 1 (DMNH); 17 mi. N Florissant, 8900 ft., 1 (FWS); Palmer Lake, 1 (CSU). ELBERT COUNTY: Elbert, 1 (CU); 6 mi. S Elbert, 1 (CU). DELTA COUNTY: *19 1/2 mi. S Colorado Highway 330 on Ragged Mountain Road, 8840 ft.,* 8 (CU); 20 mi. S Highway 330 on Ragged Mountain Road, 9000 ft., 7 (CU); 12 mi. S, 5 1/2 mi. E Collbran, 10,400 ft., 14 (KU); 6 mi. E Skyway, 10,000 ft., 2 (KU); *8 mi. E Skyway, 9500 ft.,* 18 (KU); *1/2 mi. S, 8 mi. E Skyway, 10,000 ft.,* 9 (KU); *1/2 mi. S, 8 mi. E Skyway, 10,200 ft.,* 2 (KU); *1 1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 1 (KU); *2 1/2 mi. S, 8 mi. W Skyway, 9600 ft.,* 3 (KU); Crawford, 1 (WC). GUNNISON COUNTY: 1 mi. W McClure Pass, 8650 ft., 1 (KU); Schofield Pass, 10,700 ft., 2 (UMMZ); West Muddy Creek, 1 (WC); *Gothic Primitive Area, 10,500 ft.,* 4 (UMMZ); *Copper Lake,* 1 (USNM); *Copper Gulch,* 1 (WSC); *2 mi. N Gothic,* 2 (1 KU, 1 UNM); *Copper Creek, 1 mi. NE Gothic,* 1 (KU); *2 mi. W Gothic,* 2 (UNM); *1 mi. W Gothic,* 1 (KU); *Gothic,* 29 (7 ANSP, 2 KU, 1 UMMZ, 1 UNM, 18 USNM); *Lewin Quadrangle, Gothic, 9600 ft.,* 1 (USNM); *7 mi. N Crested Butte, 9500 ft.,* 2 (KU); Somerset, 1 (USNM); *2 2/10 mi. NE Crested Butte Peak,* 1 (UMMZ); Crested Butte, 11 (1 AMNH, 2 MCZ, 1 USNM, 7 WC); *near Crested Butte,* 2 (WC); Taylor Park, 4 (DMNH); *Cement Creek,* 1 (WSC); near Beckwith Pass, 2 (UNM); Black Mesa near Crawford, 1 (CSU); 3 mi. N Almont, 8300 ft., 1 (KU); *sec. 36, T. 15 S, R. 85 W,* 2 (UMMZ); Tincup, 1 (DMNH); *1/2 mi. NW Cumberland Pass,* 1 (AMNH); *8 mi. NW Sapinero, 9500 ft.,* 2 (USNM); sec. 7, T. 49 N, R. 4 W, 8250 ft., 2 (WC); *7 1/4 mi. W Gunnison,* 1 (FWS); *1 1/4 mi. W Gunnison,* 1 (WSC); *1 mi. W Gunnison,* 1 (WSC); *5 mi. E Gunnison,* 1 (WSC); *S of Gunnison,* 2 (WSC); *1 mi. S Gunnison,* 1 (WSC); *1 1/2 mi. S Gunnison,* 2 (WSC); *2 mi. SW Gunnison,* 11 (WSC); *2 mi. S Gunnison,* 9 (WSC); 7 mi. S, 7 mi. W Gunnison, 8150 ft., 1 (KU); *4 mi. W Sapinero, 7750 ft.,* 1 (KU); Sapinero, 5 (2 DMNH, 3 USNM); *6 mi. E Sapinero,* 2 (CU); Iola, 1 (DMNH); *2 1/2 mi. S Parlin, 8000 ft.,* 1 (FWS); *5 mi. S Parlin, 8200 ft.,* 1 (FWS); 5 1/4 mi. S Parlin, 9100 ft., 1 (FWS); 16 mi. from U.S. Highway 50 up Cimarron Creek, 8750 ft., 2 (CU); 9 mi. S Powderhorn, 8575 ft., 2 (CU); *Lake Fork, Uncompahgre National Forest,* 2 (USNM). CHAFFEE COUNTY: head of Otero Reservoir, 8900 ft., 2 (KU); 12 mi. W Buena Vista, 1 (UMMZ); Buena Vista, 5 (AMNH); *6 mi. E Buena Vista,* 1 (FWS); *Cottonwood Creek,* 1 (WC); St. Elmo, 12,200 ft., 3 (USNM); *3 mi. W Salida,* 3 (KU); Salida, 2 (WC); *Poncha Creek, 10 mi. SW Salida,* 15 (1 FWS, 14 KU); *1/4 mi. N Poncha Pass, 9000 ft.,* 1 (CU); near Poncha Pass, 2 (WC). TELLER COUNTY: *12 mi. N Florissant,* 1 (FWS); 7 mi. NNE Florissant, 8900 ft., 1 (FWS);

Florissant, 3 (1 AMNH, 2 WC); Glen Cove, 3 (UMMZ); Oil Creek, 13 mi. SW Woodland Park, 1 (CSU); *1 mi. E Cripple Creek,* 1 (UNM); 1 mi. E Victor, 1 (UNM). EL PASO COUNTY: *2 mi. W Palmer Lake,* 1 (DMNH); *Palmer Lake,* 9 (DMNH); *Cascade,* 1 (USNM); *3 mi. above Manitou,* 1 (WC); Colorado Springs, 6 (AMNH); *near Colorado Springs,* 10 (WC); *5 mi. from Colorado Springs,* 1 (AMNH); *Minnehaha,* 7 (UMMZ); *Halfway,* 3 (UMMZ); *near mouth of Bear Creek Canyon,* 1 (DMNH); Pikes Peak, 12,000 ft., 1 (UMMZ); *near Ruxton Creek, Lake Moraine,* 3 (1 AMNH, 1 MCZ, 1 WC); *Bear Creek,* 2 (1 AMNH, 1 MCZ); *Bear Creek Canyon,* 1 (AMNH); *1/2 mi. S Bear Creek,* 1 (MCZ); *South Cheyenne Creek, 8000 ft.,* 1 (WC); *below Cheyenne Mountain Road,* 1 (WC); *Cheyenne Mountain Road,* 1 (AMNH). MONTROSE COUNTY: Black Canyon of the Gunnison National Monument, 6 (CU); Cushman Creek, 7000 ft., 1 (CU); Montrose, 2 (1 DMNH, 1 USNM); *3 mi. S, 30 mi. W Montrose,* 1 (KU); West Paradox Valley, 7 (DMNH); Columbine Pass, 9385 ft., 8 (CU); S of Cimarron, 1 (CU); sec. 15, T. 47 N, R. 12 W, 8400 ft., 2 (KU); 1 mi. SW junction Colorado Highway 90 and Columbine Pass Road, 9415 ft., 1 (CU); Coventry, 4 (WC). OURAY COUNTY: 6 mi. S, 3 mi. W Ridgway, 4 (KU); *Red Mountain, 10,500 ft.,* 4 (AMNH); Red Mountain, 11,000 ft., 1 (AMNH). SAN MIGUEL COUNTY: 4 mi. N Ophir, 2 (CU); 3 mi. SW Ophir, 9650 ft., 3 (CU). SAGUACHE COUNTY: 1/2 mi. E Colorado Highway 114 on road to Doyleville, 8185 ft., 1 (CU); *2 mi. NE Cochetopa Pass,* 2 (KU); *26 mi. SE Gunnison,* 3 (CSU); *5 mi. N, 22 mi. W Saguache, 10,000 ft.,* 11 (KU); Cochetopa Pass, 10,000 ft., 3 (1 ASC, 2 KU); Los Piños Pass, 10,250 ft., 1 (WC); *14 mi. E junction Powderhorn Road and Cochetopa-Lake City Road,* 1 (CU); 19 mi. E junction Powderhorn Road and Cochetopa-Lake City Road, 9100 ft., 1 (CU); 6 mi. S Colorado Highway 114 on Carnero Road, 9220 ft., 3 (CU); *11 mi. SW Saguache,* 2 (DMNH); 16 mi. S Colorado Highway 114 on Carnero Road, 1 (CU); *North Crestone Trail, 11,500 ft.,* 1 (WC); Crestone, 5 (1 AMNH, 4 WC); head of Madenos [Medano] Creek, near timberline, 4 (WC); *Great Sand Dunes National Monument,* 1 (GSDNM); *Madenos [Medano] Canyon, above Herard's cabin, 8700 ft.,* 2 (WC). FREMONT COUNTY: 19 mi. S Victor, 7500 ft., 4 (CU); 7 mi. W Cañon City, 1 (UI). CUSTER COUNTY: 10 mi. W Westcliffe, 1 (CU); 5 mi. S Wetmore, 7200 ft., 3 (CU); *7 mi. S Wetmore, 7375 ft.,* 1 (CU); *7 mi. above Wetmore,* 1 (WC); *2 mi. S Colorado Highway 96 on Colorado Highway 67, 8575 ft.,* 3 (CU); *3 mi. S Highway 96 on Highway 67, 8575 ft.,* 1 (CU); *4 mi. S Highway 96 on Highway 67, 8990 ft.,* 1 (CU); Querida, 9000 ft., 3 (WC); *11 mi. SW Wetmore, 8600 ft.,* 1 (CU); *12 mi. SW Wetmore, 8750 ft.,* 2 (CU); *13 mi. SW Wetmore, 9050 ft.,* 4 (CU); *14 mi. SW Wetmore, 9150 ft.,* 8 (CU); *1 1/2 mi. N, 1 1/2 mi. E Fairview,* 1 (KU); *7 mi. N Lake Isabel, 9000 ft.,* 1 (CU); *1 mi. W Lake Isabel,* 2 (CU); Marion Reservoir, 1 (WC). PUEBLO COUNTY: Swallows, 1 (SCSC); Rye, 1 (SCSC). DOLORES COUNTY: *Mount Wilson,* 3 (CU); Lone Mesa, 25 mi. N Dolores, 2 (USNM); *12 mi. N Rico,* 2 (CU); *6 mi. N Rico,* 2 (CU); Rico, 1 (CU). SAN JUAN COUNTY: *Mineral Creek Campground, San Juan National Forest,* 1 (CSU); Silverton, 8 (1 KU, 7 USNM); *4 mi. S Silverton,* 16 (CU); Molas Divide, 3 (DMNH). HINSDALE COUNTY: Lake City, 4 (USNM); 7 mi. S, 2 mi. W Lake City, 9000 ft., 1 (KU); Hermit, 1 (USNM). MINERAL COUNTY: 1/2 mi. E Spring Creek Pass, 10,575 ft., 2 (CU); 5 mi. above Creede, 11,000 ft., 1 (WC); *3 mi. E Creede,* 1 (KU); 2 mi. S Creede, 1 (CU); 4 mi. S, 4 mi. W Creede, 8800 ft., 5 (KU); *10 1/2 mi. SW Creede,* 1 (CU); 1/2 mi. N Alberta Park, 11,200 ft., 1 (CSU). RIO GRANDE COUNTY: Del Norte, 1 (USNM); 3 mi. S, 2 1/2 mi. W South Fork, 8800 ft., 2 (KU); Comstock Campground, Rio Grande National Forest, 8 mi. S, 11 mi. W Monte Vista, 1 (UI); 8 mi. S Monte Vista, 7600 ft., 3 (UI). ALAMOSA COUNTY: *Sangre de Cristo Range, 24 mi. E Hooper, 8300 ft.,* 4 (2 AMNH, 2 DMNH); 5 mi. SW Alamosa, 1 (ASC). HUERFANO COUNTY: 1 mi. W Gardner, 1 (DMNH); 5 mi. NE Great Sand Dunes National Monument, 1 (CU); Pass Creek Pass, 13 (CU); La Veta Pass, 35 mi. W Walsenburg, 4 (AMNH); *4 mi. W La Veta, 7100 ft.,* 1 (KU); La Veta, 2 (UMMZ); *East Spanish Peak, 10,500 ft.,* 1 (CU); Apishapa Pass, 1 (CU); 5 mi. S, 1 mi. W Cucharas Camps, 10,000 ft., 7 (KU). MONTEZUMA COUNTY: Stoner, 1 (CU); Ackmen, 4 (FMNH); 7 mi. N Dolores, 1 (CU); Ute Peak, 9 (DMNH); Mesa Verde National Park, 1 (DMNH); *Park Point, 8525 ft.,* 4 (KU); *Morfield Canyon, 7600 ft.,* 1 (KU); *1/4 mi. S, 3/4 mi. W Park Point, 8300 ft.,* 2 (KU); *head East Fork Navajo Canyon, 7900 ft.,* 1 (KU); *3 mi. N Rock Springs, 8200 ft.,* 2 (KU); *Far View Ruins, 7700 ft.,* 2 (KU). LA PLATA COUNTY: 22 mi. N Bayfield, 2 (CU); 3 mi. N Durango, 1 (WSC); *7 mi. E Durango, 7000 ft.,* 2 (KU); *1 mi. NW Florida, 6700 ft.,* 1 (KU); Florida, 23 (AMNH); *East Animas* (not found), 1 (WSC). ARCHULETA COUNTY: Gordon Creek, near Piedra River, 4 (UNM); Pagosa Springs, 4 (1 UMMZ, 1 USNM, 2 WC); Navajo River, 1 (DMNH); Chromo, 2 (DMNH). CONEJOS COUNTY: *1/2 mi. N, 1 mi. W Platoro, 9500 ft.,* 1 (KU); Platoro, 1 (FHSC); *2 mi. E Platoro,* 4 (FHSC); *2 1/2 mi. E Platoro,* 1 (FHSC); *1 mi. SW Platoro,* 4 (FHSC); *"3-5 mi. SW Platoro,"* 29 (FHSC); *5 mi. SW Platoro,* 4 (FHSC); 12 mi. NE Cumbres, 1 (AMNH); *Conejos Cañon, 8400 ft.,* 1 (USNM); *Conejos River,* 2 (USNM); Antonito, 4 (USNM); *4 mi. S, 21 mi. W Antonito,* 1 (KU); *5 mi. S, 25 mi. W Antonito,* 7 (KU); Cumbres, 1 (USNM); Osier, 3 (DMNH). COSTILLA COUNTY: Fort Massachusetts, 1 (USNM); *Blanca,* 2 (WC); *2 1/2 mi. W Fort Garland, 7900 ft.,* 4 (KU); *Ute Creek, W of Fort Garland,* 1 (CU); *W of Fort Garland,* 7 (CU); *Fort Garland,* 5 (4 UMMZ, 1 USNM); *1 mi. SW Fort Garland,* 7 (AMNH); 7 mi. N Trinchera Peak, 4 (AMNH); *5 mi. SSE Fort Garland,* 1 (AMNH); 8 mi. S, 2 mi. E Fort Garland, 8000 ft., 2 (KU); San Acacio, 7737 ft., 3 (WC); *no* *locality other than San Luis Valley,* 3 (AMNH); S edge of San Luis, 1 (CU); *4 mi. S San Luis,* 1 (CU); *2 6/10 mi. N, 3 mi. E Chama,* 1 (CU); *2 6/10 mi. N, 2 1/2 mi. E Chama, 8600 ft.,* 1 (CU); Culebra Cañon, 1 (WC). LAS ANIMAS COUNTY: Trinidad, 1 (USNM); Fisher Peak, 8000 ft., 2 (1 USNM, 1 WC); Tercio, 8000 ft., 4 (WC).

Additional records: LARIMER COUNTY: *North Fork Cache la Poudre River, 9600 ft.* (Gordon, 1938: 78). GILPIN COUNTY: *Jumbo Mountain* (Williams and Finney, 1967:74). MESA COUNTY: *Hightower Ranger Station, Collbran* (P. H. Miller, 1964:53). LAKE COUNTY: Twin Lakes (A. H. Howell, 1929:48, as *consobrinus*). GUNNISON COUNTY (Durrant and Robinson, 1962:244): *Willow Creek, 2 1/2 mi. N Gunnison River, 7500 ft.; Dry Gulch, 1 1/2 mi. N Gunnison River, 7900 ft.; Red Creek, 1 mi. above Gunnison River, 7544 ft.; confluence of Beaver Creek and Gunnison River, 7600 ft.; Dry Gulch, 1 1/4 mi. N Gunnison River, 7900 ft.; butte NW of Dry Gulch, 7800 ft.; Gunnison River at confluence with Red Creek, 7300 ft.; Gunnison River, 1/2 mi. E Cebolla Creek, 7400 ft.; 2 mi. from mouth of Cebolla Creek, 7400 ft.* EL PASO COUNTY: *Seven Falls* (Walker, 1945:308). RIO GRANDE COUNTY: *3 mi. W South Fork* (Tomberlin, 1968: 63, as *caryi*). COSTILLA COUNTY: *San Luis Hills* (Warren, 1913a:11).

Eutamias quadrivittatus

Colorado Chipmunk

The Colorado chipmunk ranges widely in the central, southern, and western parts of the state, where it typically inhabits areas of broken rock and open coniferous woodland. Extreme elevations of specimens examined are Regnier, Baca County, about 4200 feet, and Red Mountain, 10,500 feet, Ouray County. Considerable confusion has arisen in the literature because of superficial similarities in the appearance of *Eutamias quadrivittatus, Eutamias umbrinus,* and *Eutamias minimus.* Two species of chipmunk frequently are encountered at the same locality in the mountains of Colorado, and much work is needed to document the ecological relationships among the taxa. White (1953a) revised the species *E. quadrivittatus* and *E. umbrinus,* and Beck (1966) reported on fleas of *E. quadrivittatus* from Mesa Verde National Park. Nadler (1964) discussed the karotype of the Colorado chipmunk based on material from Great Sand Dunes National Monument. Wadsworth (1969) reported on some aspects of growth and reproduction of the species in Utah.

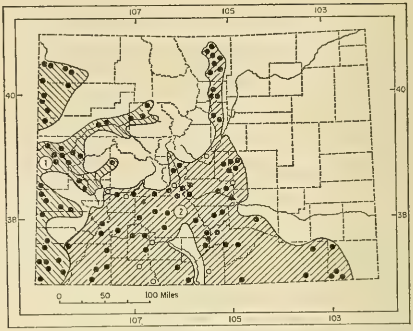


FIG. 41. Distribution of *Eutamias quadrivittatus* in Colorado. 1. *E. q. hopiensis.* 2. *E. q. quadrivittatus.* For explanation of symbols, see p. 9.

Eutamias quadrivittatus hopiensis Merriam

Eutamias hopiensis Merriam, Proc. Biol. Soc. Washington, 18:165, 29 June 1905; type locality, Keam Canyon, Navajo Co., Arizona.

Eutamias quadrivittatus hopiensis, A. H. Howell, Jour. Mamm., 3:184, 4 August 1922.

Distribution in Colorado.—Western part of state north to Yampa River, eastward in suitable habitat to Eagle and Gunnison counties (Fig. 41).

Comparison.—For comparison with *E. q. quadrivittatus,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of six males, followed by those of 10 females, all from west-central Mesa County, are: 205.0 (194-215), 209.6 (202-221); 89.3 (83-93), 90.0 (83-95); 32.2 (31-34), 32.6 (31-35); 17.7 (15-22), 16.8 (15-21). Selected cranial measurements are presented in table 9.

Remarks. — Intergradation between *E. q. hopiensis* and *E. q. quadrivittatus* has not been certainly demonstrated in Colorado. In the Gunnison River drainage, specimens are lacking from eastern Delta and northeastern Montrose counties. This is a critical area, because to the east, at the eastern end of the Black Canyon of the Gunnison, Durrant and Robinson (1962:245) captured *E. q. quadrivittatus,* and *E. q. hopiensis* occurs to the south and west of the area in question (and also along the North Fork of the Gunnison, north of the

TABLE 9
Selected cranial measurements of three species of *Eutamias*.
(Measurements as defined by White, 1953a.)

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Interorbital constriction	Length of nasals	Length of mandibular toothrow	Condyloalveolar length of mandible
Eutamias dorsalis utahensis, Moffat County, west of Vermillion Creek							
Mean, 9 ♂	35.28	32.74	19.36	7.80	10.77	5.44	18.50
Minimum	34.9	32.1	18.8	7.2	10.0	5.2	18.1
Maximum	36.0	33.2	20.1	8.2	11.3	5.6	19.0
Mean, 15 ♀	35.39	32.99	19.75	7.80	10.95	5.47	18.76
Minimum	34.8	32.4	19.2	7.5	10.5	5.3	18.3
Maximum	36.1	33.8	22.5	8.2	11.7	5.7	19.5
Eutamias quadrivittatus hopiensis, west-central Mesa County							
Mean, 6 ♂	34.80	32.40	19.00	7.48	10.45	5.62	18.43
Minimum	34.0	31.6	18.4	7.2	9.4	5.4	17.7
Maximum	35.5	32.9	19.8	7.8	11.0	5.9	18.9
Mean, 10 ♀	35.19	32.65	19.72	7.78	10.77	5.62	18.76
Minimum	34.4	32.0	19.1	7.2	10.3	5.4	18.5
Maximum	36.4	33.5	20.4	8.2	11.5	6.0	19.4
Eutamias quadrivittatus quadrivittatus, Larimer and Boulder counties							
Mean, 5 ♂	36.40	——	19.74	7.62	11.58	5.72	19.24
Minimum	35.9	——	19.4	7.4	11.3	5.6	19.1
Maximum	37.1	——	20.2	7.8	11.8	5.8	19.6
vicinity of Cañon City, Fremont County							
Mean, 13 ♂	35.73	32.78	19.35	7.92	11.16	6.11	18.86
Minimum	35.5	32.3	19.0	7.5	10.7	5.8	18.1
Maximum	36.1	33.4	19.9	8.5	12.2	6.6	19.4
Mean, 12 ♀	36.04	32.88	19.61	7.70	11.47	5.97	18.96
Minimum	35.5	31.7	19.2	7.1	11.0	5.5	18.5
Maximum	36.7	33.5	20.1	8.2	12.1	6.3	19.3
western Baca County							
Mean, 10 ♂	35.08	32.49	19.42	7.72	10.90	5.87	18.58
Minimum	34.0	31.0	18.9	7.4	10.4	5.5	17.8
Maximum	36.2	33.9	20.3	7.9	11.6	6.2	19.2
Mean, 5 ♀	35.30	31.80	19.40	7.98	11.28	5.90	18.88
Minimum	35.1	31.4	19.4	7.5	10.6	5.7	18.1
Maximum	35.4	32.1	19.4	8.4	11.7	6.1	19.4
vicinity of Bondad, La Plata County							
KU 34693, ♂	35.8	32.8	19.8	7.8	11.3	5.9	18.5
KU 34692, ♀	36.9	34.4	20.3	7.8	11.0	6.1	19.8
Eutamias umbrinus montanus, Larimer and Boulder counties							
Mean, 14 ♂	35.67	32.73	19.05	7.68	11.03	5.66	18.61
Minimum	35.0	31.2	18.6	7.3	10.7	5.5	18.0
Maximum	36.6	33.8	19.3	8.4	11.6	5.9	19.2
KU 20100, ♀	36.3	33.2	19.5	7.5	11.7	5.8	18.9
KU 20102, ♀	——	33.2	19.2	7.2	——	5.8	18.6
USNM 69258, ♀	36.5	33.5	19.4	7.6	11.1	5.7	19.2

West Elk Mountains). Possible intergradation between the two subspecies is indicated by three specimens from a place 1 1/2 mi. NW of Dolores, Montezuma County, herein assigned to *E. q. quadrivittatus.* These individuals are immature, but are slightly more reddish than specimens from farther to the north and east. The locality is one where one would expect *a priori* that intergradation might occur.

Intergradation between the subspecies in question occurs in the Chuska Mountains of New Mexico and the Tunitcha Mountains of Arizona. A. H. Howell (1929:84) and White (1953a:570) pointed out that topotypes of *hopiensis* represent intergrades between that subspecies, as currently understood, and *E. q. quadrivittatus.*

The hiatus between the ranges of the two subspecies (Fig. 41) in eastern Dolores and San Miguel counties is in part artifactual, resulting from lack of collecting there. The forested Uncompahgre Plateau is not occupied by *E. quadrivittatus; E. minimus* is abundant there and *E. q. hopiensis* occupies the numerous dry canyons on the flanks of the plateau.

The ranges of *E. q. hopiensis* and *E. umbrinus montanus* approach each other along the Colorado River and its northern tributaries. A. H. Howell (1929:84) remarked that "a series of seven specimens from Yarmany Creek, near McCoy [Eagle County] . . . are typical of [*hopiensis*], but in the same locality was taken a single specimen seemingly referable to *quadrivittatus.*" The latter specimen, attributed by Howell (*op. cit.*:82, footnote) to the Warren Collection, was not seen by me. It is herein referred to *Eutamias umbrinus montanus* on geographic grounds, and admitted as an additional record in the account of that subspecies. The ranges of *E. q. hopiensis* and *E. u. montanus* also meet or overlap near the head of Douglas Creek on the Roan Plateau, south of Rangely.

Records of occurrence.—Specimens examined, 168, distributed as follows: MOFFAT COUNTY: Ladder [Ladore?] Canyon, Dinosaur National Monument, 1 (CU); Castle Park, Yampa Canyon [sec. 18, T. 7 N, R. 102 W], 1 (CU); *Mantle's Cave [sec. 18, T. 7 N, R. 102 W],* 1 (CU); *above Castle Park,* 4 (CU); 5 mi. E Mantle Ranch [sec. 17, T. 7 N, R. 102 W] on Hell's Canyon Road to Elk Springs, 5750 ft., 1 (CU); *Lily,* 1 (DMNH); S bank Yampa River, 4 mi. NNW Cross Mountain, 5 (CM); 11 mi. N, 11 mi. W Rangely, 6000 ft., 3 (KU). RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 5 (USNM); *5 mi. SW Rangely,* 1 (CU); 7 mi. SW Rangely, 6350 ft., 5 (CU); *13 mi. SW Rangely, 6300 ft.,* 1 (CU); *17 mi. SW Rangely, 6150 ft.,* 2 (CU); 20 mi. SW Rangely, 6550 ft., 4 (3 CU, 1 USNM); 26 mi. S Rangely, 1 (CM); *Roan Plateau, 14 mi. SE Dragon, Utah, 7000 ft.,* 1 (USNM). GARFIELD COUNTY: Atchee, 6600 ft., 2 (CU); near Rifle, 5 (DMNH); 8 mi. W Rifle, 1 (USNM). EAGLE COUNTY: McCoy, 2 (USNM); *Yarmany Creek, near McCoy, 6900 ft.,* 5 (WC); between Eagle and Wolcott, 6800 ft., 1 (WC); Dotsero, 1 (USNM). MESA COUNTY: 1 1/2 mi. S Loma, 6000 ft., 2 (KU); Book Cliff Coalmine, 7 mi. N Grand Junction, 2 (CU); *1/4 mi. W Fruita,* 1 (CU); 2 mi. S Fruita, 1 (CU); 3/4 mi. NW Cameo, 1 (CU); *1 mi. W Colorado National Monument, 6800 ft.,* 1 (CU); *1/4 mi. W Colorado National Monument, 6600 ft.,* 2 (CU); *Fruita Cañon,* 3 (CU); *Campground, Colorado National Monument,* 7 (CU); *warehouse, Colorado National Monument,* 1 (CU); *Colorado National Monument,* 4 (3 CNM, 1 CU); *3 mi. W Grand Junction,* 1 (CM); Grand Junction, 14 (1 CSU, 3 FMNH, 2 MCZ, 8 WC); Land's End Road, 8050 ft., 1 (CU); Glade Park P. O., 6750 ft., 8 (CU); *Glade Park,* 3 (FMNH); [near] Whitewater, 8050 ft., 4 (CU); Sinbad Valley, 1 (USNM). GUNNISON COUNTY: Somerset, 1 (USNM); 1 mi. E Somerset, 1 (KU). MONTROSE COUNTY: 10 mi. SW Delta, 7025 ft., 1 (CU); *8 mi. W Olathe,* 1 (DMNH); West Paradox Valley, 5 (DMNH); *Bedrock, 5150 ft.,* 4 (CU); 5 mi. E Naturita, 1 (KU); Coventry, 9 (2 USNM, 7 WC). SAN MIGUEL COUNTY: Gypsum Valley, 1 (DMNH); *near Coventry,* 1 (WC). DOLORES COUNTY: 1 mi. N Cahone, 6900 ft., 1 (KU). MONTEZUMA COUNTY: Ackmen, 1 (FMNH); Cortez, 1 (WC); *S of Cortez,* 2 (WC); Ashbaugh's Ranch [Moqui], 2 (WC); 1 mi. S, 22 mi. W Cortez, 5000 ft., 1 (KU); Ute Peak, 1 (DMNH); Mesa Verde, 2 (USNM); *Mesa Verde National Park,* 12 (9 CU, 3 RMNP); *Lower Well, Prater Canyon, 7430 ft.,* 1 (KU); Headquarters, Mesa Verde National Park, 3 (KU); *Spruce Tree House, Mesa Verde National Park,* 4 (DMNH); Four Corners, 3 (DMNH). County unknown: *W of Blanchard,* 1 (USNM).

Additional records: MESA COUNTY: De Beque (A. H. Howell, 1929:84); *Serpent's Trail, Colorado National Monument* (P. H. Miller, 1964:53). DELTA COUNTY: 15 mi. NW Delta (Long and Cronkite, 1970:290).

Eutamias quadrivittatus quadrivittatus (Say)

Sciurus quadrivittatus Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 2:45 (footnote), 1823; type locality restricted by Merriam (1905:163) to along the Arkansas River, about 26 mi. below Cañon City, Fremont Co., Colorado.

Eutamias quadrivittatus, Miller and Rehn, Proc. Boston. Soc. Nat. Hist., 30:43, 27 December 1901.

Eutamias quadrivittatus animosus Warren, Proc. Biol. Soc. Washington, 22:105, 25 June 1909; type locality, Irwin's Ranch [T. 29 S, R. 52 W], Las Animas Co., Colorado (regarded as inseparable from *E. q. quadrivittatus* by A. H. Howell, 1929:184).

Distribution in Colorado.—Foothills, lower mountains, and canyons of Eastern Slope, north nearly to Wyoming boundary; higher parts of Raton Section; Western Slope south of Gunnison River (Fig. 41).

Comparisons.—From *E. q. hopiensis*, the subspecies of western Colorado and adjacent Utah, Arizona, and New Mexico, *E. q. quadrivittatus* differs in larger cranial and external size, black rather than tawny dorsal stripes, yellowish to brown rather than rich reddish dorsal ground color, and grayer, less reddish, color of crown, flanks, and limbs. For extended comparison with *E. umbrinus montanus*, a subspecies easily confused with *E. q. quadrivittatus*, see remarks beyond.

Measurements.—Average (and extreme) external measurements of 13 males, followed by those of 12 females, all from the vicinity of Cañon City, Fremont County, are: 221.2 (215-229), 219.0 (200-228); 99.8 (91-106), 98.2 (94-104); 32.9 (31-34), 33.2 (33-34). Mean (and extreme) external measurements of 10 males, followed by those of five females, all from Baca County, are: 223.8 (206-243), 231.6 (214-240); 102.9 (98-110), 99.2 (97-104); 35.1 (35-36), 36.2 (35-37); 21.4 (20-23), 21.2 (21-22). Selected cranial measurements are presented in table 9.

Remarks.—The systematics of Coloradan chipmunks has been a subject of considerable misinterpretation. Merriam (1905) was the first to establish the distinction between *E. q. quadrivittatus* and *Eutamias minimus operarius*, taxa that are superficially similar and that frequently occur sympatrically. Where the two species do occur together, the Colorado chipmunk is readily recognized by its larger size, notably less animated behavior, and a predilection for rocky sites instead of wooded habitats. The altitudinal range of the Colorado chipmunk on the Eastern Slope is considerably more restricted than that of the least chipmunk. White (1953c) and Lechleitner (1969:83) compared the bacula of the two species.

White (1953a) showed that the large chipmunks occurring at higher elevations in northwestern and central Colorado are specifically distinct from those of the mountains elsewhere in the state. The newly recognized population was regarded as representing a previously undescribed subspecies, *Eutamias umbrinus montanus*.

White (*op. cit.*:578) noted three morphological criteria by which *E. quadrivittatus* might be distinguished from *E. umbrinus* in Colorado. (1) The width of the base of the baculum of *E. quadrivittatus* is less than one-fourth the length of the shaft; bacula of the two species were illustrated by White (1953a, 1953c) and Lechleitner (1969:83). (2) The cranial breadth of specimens of *E. quadrivittatus* averages greater than that of specimens of *E. umbrinus*. (3) *E. quadrivittatus* is paler in color, more yellowish to reddish buff and less brownish, than *E. umbrinus*. An additional cranial feature that I have found useful in distinguishing specimens of the two species is the breadth of the jugal bone. In skulls of *quadrivittatus* the jugal is broad in lateral aspect and flares noticeably dorsad (mean width in 30 individuals, 1.96, range, 1.7-2.4). In *umbrinus*, on the other hand, the bone typically is conspicuously narrower (mean width in 22 individuals, 1.49, range, 1.2-1.8), and the entire zygomatic arch is lighter and more slender. The jugal in *E. q. hopiensis* is narrower, on the average, than that of the nominate subspecies (mean of nine individuals, 1.84, range 1.7-2.2), but is nonetheless broader than in *umbrinus*.

When series of skulls of the two species are compared, skulls of *quadrivittatus* are seen to be relatively shorter and relatively and absolutely broader than those of *umbrinus*. The mean ratio of zygomatic breadth to greatest length of skull in *quadrivittatus* is 0.5465 ($N=36$, range, 0.535-0.569). In a sample of *umbrinus*, the mean ratio is 0.5360 ($N=16$, range, 0.524-0.548). Absolute differences between these ratios are small, but the cranial differences that the ratios reflect are, in fact, quite visible to the unaided eye. Also, *quadrivittatus* has a less elongate braincase than does *umbrinus*.

Furthermore, there seem to be ecological differences between the species where their

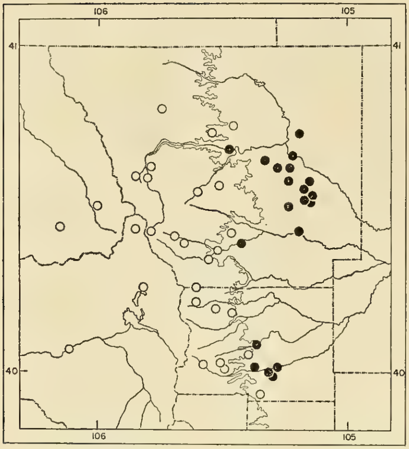


FIG. 42. Detailed map of Larimer and Boulder counties and parts of adjacent counties, showing distribution of *Eutamias quadrivittatus* (closed circles) and *Eutamias umbrinus* (open circles). The fine, irregular north-south line is the 8000-foot contour. Localities plotted are identified with an asterisk in respective lists of specimens examined.

ranges approach. In the mountains of northern and central Colorado, *E. quadrivittatus* is consistently found at lower elevations. A similar relationship exists between the Uinta and Colorado chipmunks on the Western Slope. In areas where only a single species of large chipmunk occurs, that species is found to have a wider altitudinal range. In southwestern Colorado, for example, *E. quadrivittatus* is recorded from localities above 10,000 feet; in Larimer and Boulder counties, records are consistently below 8000 feet. Likewise, in north-central Colorado, *E. umbrinus* occurs mostly above 8500 to 9000 feet, but in the White River Valley, where the species is removed from the range of other large chipmunks, records are available as low as 6500 feet. This pattern is illustrated elsewhere in Colorado by comparison of lists of specimens examined.

The known distributions of the two species in question in north-central Colorado are illustrated in figure 42. The fine, irregular north-south line in the figure is the 8000-foot contour. It is noteworthy that this is the approximate elevation at which open woodland cedes dominance to closed coniferous forest. Long and Cronkite (1970) presented distributional data on the two species in a zone of near sympatry in Gunnison and Chaffee counties.

Long and Cronkite (1970) remarked on the large size of two specimens from the vicinity of Bondad, La Plata County. External measurements of these two specimens (a young adult male and an adult female, KU 34693 and 34692) are, respectively, 249, 241; 102, 112; 34, 36; 18, 18. Representative cranial measurements are presented in table 9. The female is indeed a remarkably large individual; cranial measurements lie near or beyond the upper extremes of a sample of topotypes. Cranial measurements (other than zygomatic breadth) of the male are near the mean of the sample from Cañon City. Perhaps the external measurements were incorrectly taken and thus distortedly large, because other specimens from La Plata County do not bear out the suspicion of Long and Cronkite (*op. cit.*:288) that ". . . the Bondad specimens may belong to an undescribed subspecies. . . ." I would agree with the aforementioned authors that the specimens show no intermediacy between *E. q. quadrivittatus* and *E. q. hopiensis.* One would expect to find intergradation between the two in the southern La Plata Mountains, but to date this is unknown. Durrant and Dean (1961:166) remarked on the lack of evidence of intergradation in specimens from the Navajo Reservoir Basin of New Mexico and Colorado.

Warren (1909) proposed the name *Eutamias quadrivittatus animosus* for chipmunks from southeastern Colorado. A. H. Howell (1922:184) listed *animosus* as a synonym of *quadrivittatus* without comment. Later, Howell (1929:82) maintained the synonymy, remarking that the worn, faded pelage of the holotype was not typical of the specimens then known from southeastern Colorado, and that other material from that area agreed well in color with topotypical *quadrivittatus.* The somewhat better series of specimens from Baca and eastern Las Animas counties that now is available supports the contention of Warren (1909) that chipmunks from that area are distinctive insofar as color is concerned. They also are large in external size, but cranially they are indistinguishable from specimens from Cañon City. The population is distributed on a series of disjunct, wooded cuestas and escarpments. As such it is semi-isolated from a nearly continuous montane population that reaches its eastern limit in Colorado in the vicinity of Trinidad.

Probably this variation is best regarded as micro-geographic. The population of Colorado chipmunks in Baca and Las Animas counties is not accorded nominal recognition herein; however, in a thorough analysis of geographic variation throughout the range of the species, the name *animosus* might well be raised from synonymy.

Records of occurrence.—Specimens examined, 347, distributed as follows (an asterisk denotes localities plotted on the detailed distribution map, Fig. 42): 10 mi. N, 6 mi. W Fort Collins,* 1 (CSU); *Bennett Creek,* 1 (CSU); 15 mi. up Poudre Canyon from Fort Collins,* 1 (CSU); *7 mi. N, 13 mi. W Fort Collins,** 1 (CSU); *10 mi. NW Fort Collins,* 2 (CSU); *35 mi. [by road?] W Laporte, 7500 ft.,* 1 (CSU); 7 mi. W Laporte,* 1 (CSU); *3 mi. W Bellevue,** 1 (CSU); *2 mi. SW Laporte,* 1 (CSU); *3 mi. N, 8 mi. W Fort Collins,* 1 (CSU); *8 mi. W Fort Collins,** 1 (CSU); *3 mi. W Fort Collins,** 1 (CSU); *1 mi. S, 4 mi. W Fort Collins,* 1 (CSU); *1 1/2 mi. S, 4 mi. W Fort Collins,** 1 (CSU); *2 mi. S, 3 mi. W Fort Collins,* 1 (CSU); *Horsetooth Gulch,* 1 (CSU); *2 8/10 mi. S, 3 2/10 mi. W Fort Collins,* 1 (CSU); 3 mi. S, 3 mi. W Fort Collins, 1 (CSU); *4 1/2 mi. SW Fort Collins,** 1 (CSU); *1 1/2 mi. SW Dixon Reservoir,** 1 (CSU); *3 mi. S, 4 mi. W Fort Collins,* 1 (CSU); *Spring Canyon,* 1 (CSU); *Spring Canyon Dam,** 2 (CSU); Buckhorn Canyon,* 1 (CSU); Arkins,* 1 (USNM); 6 3/10 mi. SW Drake,* 1 (CSU). BOULDER COUNTY: 2 3/10 mi. above mouth of James Creek, Lefthand Canyon, 7000 ft.,* 1 (CU); *5 mi. W Boulder,** 5 (USNM); Boulder,* 15 (6 ANSP, 1 CU, 5 FMNH, 3 USNM); *Bluebell Canyon,* 1 (CU); *Gregory Canyon,** 1 (CU); Flagstaff Mountain,* 1 (CU); *Freese's Station* (not found), 2 (CSU). JEFFERSON COUNTY: 4 mi. W Golden, 2 (DMNH); *Lookout Mountain, near Golden,* 1 (WC); Bear Creek, 1 (MCZ); *head of Chimney Gulch* (not found), 1 (DMNH). GUNNISON COUNTY: Sapinero, 3 (USNM); Iola, 1 (DMNH); 1/2 mi. E Colorado Highway 114 on road to Doyleville, 8185 ft., 1 (CU). CHAFFEE COUNTY: Cottonwood Springs, 1 (UMMZ); 5 mi. W Buena Vista, 1 (UMMZ); *Buena Vista,* 6 (2 AMNH, 2 UMMZ, 2 USNM); 1 1/2 mi. S Monarch, 3 (FMNH); Salida, 3 (WC); Poncha Creek, 10 mi. SW Salida, 1 (KU). TELLER COUNTY: Divide, 1 (WC). EL PASO COUNTY: 8 mi. N Colorado Springs, 6000 ft., 1 (MCZ); Cascade, 8000 ft., 1 (USNM; *3 mi. N Colorado Springs,* 4 (WC); *one-third way up Pikes Peak Trail,* 1 (USNM); *Minnehaha,* 3 (AMNH); *Halfway,* 1 (AMNH); Colorado Springs, 1 (FMNH); *near Colorado Springs, between Bear and Cheyenne Creeks,* 2 (WC); *Cheyenne Mountain,* 1 (WC). OURAY COUNTY: Red Mountain, 10,500 ft., 1 (AMNH). SAGUACHE COUNTY: Cochetopa Pass, 1 (CSU); *5 mi. N, 22 mi. W Saguache, 10,000 ft.,* 1 (KU); 3 mi. N, 21 mi. W Saguache, 9100 ft., 1 (KU); Los Piños Pass, 10,250 ft., 2 (CU); 2 mi. N, 2 mi. E Crestone, 8300 ft., 1 (KU); 1 1/2 mi. N Crestone, 8050 ft., 1 (KU); Crestone, 1 (WC); 16 mi. S Colorado Highway 114 on Carnero Road, 9375 ft., 1 (CU); 5 mi. NE Headquarters, Great Sand Dunes National Monument, 1 (GSDNM); *Madenos [Medano] Cañon, above Herard's, 8100 ft.,* 1 (WC). FREMONT COUNTY: 12 1/2 mi. NE Salida, 1 (CSU); *19 mi. S Victor, 6800 ft.,* 1 (CU); 23 mi. S Victor, 7500 ft., 1 (CU); 7 mi. W Cañon City, 6300 ft., 6 (1 FMNH, 5 UI); Cañon City, 71 (USNM); Howard, 4 (WC); *3 mi. below Howard,* 1 (WC); *Rockvale,* 3 (FMNH); *8 mi. SE Portland,* 2 (CU). CUSTER COUNTY: Hardscrabble Canyon, 7 mi. above Wetmore, 1 (WC); *4 mi. S Colorado Highway 96 on Colorado Highway 76 [67?], 8990 ft.,* 1 (CU); Querida, 3 (WC); *near Querida,* 1 (WC); *San Isabel,* 1 (SCSC). PUEBLO COUNTY: 25 mi. SE [?] Pueblo, 1 (CU). SAN JUAN COUNTY: Silverton, 1 (USNM). HINSDALE COUNTY: 7 mi. S, 2 mi. W Lake City, 9000 ft., 4 (KU). MINERAL COUNTY: 4 1/2 mi. SW Creede, 8600 ft., 7 (CU); *Wagon Wheel Gap,* 1 (WC); 4 mi. S, 6 mi. E Wagon Wheel Gap, 4 (KU); 10 mi. NE Wolf Creek Pass, 8625 ft., 1 (CU). ALAMOSA COUNTY: 22 mi. E Mosca, 1 (USNM); *Mosca Creek, 8200 ft.,* 2 (WC); *Great Sand Dunes National Monument,* 8 (CU). HUERFANO COUNTY: 12 2/10 mi. N Gardner, 1 (UNM); La Veta Pass, 35 mi. W Walsenburg, 1 (AMNH); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 2 (KU). MONTEZUMA COUNTY: 1 mi. NW Dolores, 3 (UI). LA PLATA COUNTY: 22 mi. N Bayfield, 1 (CU); *21 mi. N Bayfield,* 2 (AMNH); *18 mi. N Bayfield,* 1 (CU); Bayfield, 1 (USNM); Florida, 24 (14 AMNH, 10 FMNH); *2 mi. NE Bondad, 6100 ft.,* 1 (KU); Bondad, 4 (3 DMNH, 1 KU). CONEJOS COUNTY: 24 mi. SW Alamosa, 1 (ASC); 7 mi. E Antonito, 1 (USNM). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 1 (WC); Trinidad, 6000 ft., 15 (3 CU, 5 DMNH, 7 USNM); Mesa de Maya, 1 (UMMZ); *Jimmie Creek,* 2 (DMNH); Long Canyon, near Martinsen, 1 (USNM). BACA COUNTY: *West Fork Hackberry Creek, 4590 ft.,* 3 (CU); *West Fork Hackberry Creek, 4625 ft.,* 2 (CU); Gaume's Ranch, Shell Rock Canyon, 1 (WC); Skull Canyon, 5000 ft., 1 (CU); Furnace [Furnish] Canyon, 2 (DMNH); Regnier, 2 (DMNH); *no locality other than county,* 1 (KU).

Additional records (A. H. Howell, 1929:82, unless otherwise noted): LARIMER COUNTY: *Soldier Canyon; Bellvue; [near] Fort Collins; "Spring Canyon, 7 miles southeast* [should read southwest] *of Fort*

Collins." PARK COUNTY: Tarryall Creek Camp. GUNNISON COUNTY (Durrant and Robinson, 1962:245-246): *Black Canyon of the Gunnison, 5 mi. W Sapinero;* Black Canyon of the Gunnison, 8 mi. W Sapinero; Cebolla Creek, 2 mi. up from Gunnison River, 7420 ft.; *5 mi. above mouth of Lake Fork, 7300 ft.; 5 1/2 mi. above mouth of Lake Fork, 7400* ft. CHAFFEE COUNTY: Willow Creek, near Maysville, approximately 8000 ft. (Long and Cronkite, 1970:290). FREMONT COUNTY: 18 mi. S, 7 mi. W Colorado Springs (White, 1953a:567). RIO GRANDE COUNTY: 3 mi. W South Fork (Tomberlin, 1968:63). ALAMOSA COUNTY: *Sangre de Cristo Range, 24 mi. E Hooper* (White, 1953a:567). ARCHULETA COUNTY: Pagosa Springs (Warren, 1912a:5); Chromo. COSTILLA COUNTY: San Luis Hills, near San Acacio (Warren, 1913a:11).

Eutamias umbrinus

UINTA CHIPMUNK

The Uinta chipmunk occurs at higher elevations in central Colorado and widely in western Colorado, ranging from an elevation of about 6500 feet along the White River to approximately 12,000 feet in Lake County. The natural history of *Eutamias umbrinus* in Colorado is virtually unknown, and studies of ecological relationships among montane chipmunks in the state are to be encouraged. Nadler and Block (1962) reported on the karyotype of *E. umbrinus* and Sutton and Nadler (1969) discussed chromosomal evolution in North American species of *Eutamias.* Gordon (1936, 1938, 1943) made behavioral observations on chipmunks on the North Fork of the Cache la Poudre River, 9500 feet; probably the subjects were *E. umbrinus.*

Eutamias umbrinus montanus White

Eutamias umbrinus montanus White, Univ. Kansas Publ., Mus. Nat. Hist., 5:576, 1 December 1953; type locality, 3 mi. S, 1/2 mi. E Ward, 9400 ft., Boulder Co., Colorado.

Distribution in Colorado.—Higher elevations in mountains of central part of state, south at least to northern Gunnison and Chaffee counties; widely distributed in montane areas of western Colorado north of Colorado River (Figs. 39 and 42).

Measurements.—Mean (and extreme) external measurements of 14 males from Boulder and Larimer counties, followed by measurements of three females from Boulder County, are: 228.5 (215-235), 228, 231, 220; 101.6 (93-110), 95, 96, 88; 33.8 (33-34), 35, 35, 34; 18.0 (16-19), 18, 19, —. A male weighed 66.2, two females, 65.8 and 68.7. Representative cranial measurements are presented in table 9.

Remarks.—For extended comparison with *Eutamias quadrivittatus,* see the account of that species.

The range of *E. u. montanus* is presently separated from the ranges of other subspecies of the Uinta chipmunk by the unsuitable habitat of the Wyoming Basin.

Further study is needed of ecological relationships between *E. umbrinus* and *E. quadrivittatus* in Colorado. Comments on the known ecological distribution of the two species are made in the account of the Colorado chipmunk. Fig. 42 is a detailed map of known distribution of the two species in Larimer and Boulder counties and adjacent areas. For details of distribution in parts of Gunnison and Chaffee counties, see Long and Cronkite (1970).

Two young adults from a locality 2 mi. SW of Aspen (CU 5558-59, a female and male, respectively) are much more reddish than is typical of *E. u. montanus,* especially on the flanks, feet, legs, and shoulders. The male was preserved in formalin-phenol-glycerin for 38 days prior to preparation. The female evidently was not so preserved, because the skull of that individual is not at all macerated (preservation in FPG apparently weakens sutures that are not completely ankylosed). The two skins are essentially the same color, so evidently preservation in fluid is not responsible for the peculiar pelage of the specimens. My first reaction upon seeing these specimens was that they appeared intermediate between *E. u. montanus* and *E. q. hopiensis.* In external and cranial size and in conformation of skull, the specimens agree better with *montanus,* to which subspecies they are tentatively referred. The single additional specimen examined from Pitkin County does not exhibit the reddish coloration; further work is needed in the area before the significance of the above-mentioned specimens can be assessed.

Records of occurrence.—Specimens examined, 140, distributed as follows (an asterisk denotes localities plotted on the detailed distribution map, Fig. 42): JACKSON COUNTY: Mount Zirkel, 9775 ft., 4 (WC); Buffalo Pass, 10,780 ft., 2 (WC); 8 mi. W

Cameron Pass,* 1 (CU); *Homestead Ranch*,* 1 (WC). LARIMER COUNTY: 10 mi. W Red Feather Lakes, 8500 ft.,* 1 (CSU); 2 mi. E Log Cabin,* 1 (WC); *Elkhorn*,* 1 (CSU); *4 mi. NE Chambers Lake*,* 2 (CU); *46 mi. W Laporte*, 1 (CSU); *1 mi. W Chambers Lake*, 2 (CU); Chambers Lake,* 2 (CU); *Cache la Poudre River, 9500 ft.*, 1 (USNM); *38 mi. W Fort Collins, 8900 ft.*, 1 (CSU); *Pennock Pass*,* 1 (CSU); Pingree Park,* 3 (2 CSU, 1 KU); *Devil's Gulch, 6 mi. N Estes Park*,* 2 (RMNP); *20 mi. [by road] W Estes Park, near Milner Pass, 10,000 ft.*,* 2 (CU); *Fall Creek, 9700 ft.*,* 1 (USNM); *Willow Park*,* 1 (UMMZ); *Trail Ridge Road*, 3 (RMNP); Estes Park,* 15 (1 KU, 2 MCZ, 12 USNM); *2 1/2 mi. SW Estes Park, 7600 ft.*, 2 (KU); *3 1/2 mi. SW Estes Park*,* 1 (KU); Longs Peak,* 7 (USNM). RIO BLANCO COUNTY: 1 mi. NW Pagoda Peak, 10,400 ft., 1 (KU); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 1 (CM); *Upper Dry Fork, 6500 ft.*, 4 (AMNH); *Dry Fork, White River, 6500 ft.*, 2 (AMNH); 15 mi. SE Meeker, 1 (CM); *West Fork Douglas Creek, 8000 ft., 25 mi. S Rangely*, 9 (CM); 29 mi. S Rangely, 1 (CM); *Compass Creek, 9000 ft.* (not found), 7 (AMNH). GARFIELD COUNTY: 10 mi. N New Castle, 1 (WC). GRAND COUNTY: Lulu City,* 1 (RMNP); Grand Lake, 8300 ft.* 5 (WC); Hot Sulphur Springs, 7900 ft.,* 2 (WC); near Sheephorn Pass, 8280 ft., 1 (WC). BOULDER COUNTY: *Wild Basin Ranger Station*,* 2 (WC); *12 1/2 mi. S Estes Park, 8400 ft.*,* 1 (KU); 2 mi. N Raymond,* 1 (RMNP); Gold Hill,* 9 (USNM); *1 mi. S Gold Hill, 8200 ft.*, 1 (KU); *3 mi. S Ward, 9000 ft.*,* 5 (KU); 3 mi. S, 1/2 mi. E Ward, 9400 ft., 1 (KU); *3 1/2 mi. S Ward, 9400 ft.*, 1 (KU); *3 mi. SSW Ward, 9450 ft.*, 1 (CU); *5 mi. SW Ward, 10,900 ft.*,* 1 (CU); *11 mi. W Boulder, 7500 ft.*,* 1 (KU); *Science Lodge, 8 mi. NW Nederland*, 1 (CU); 3 mi. E Pinecliff,* 2 (WC). CLEAR CREEK COUNTY: Davidson Mine, 3 mi. SW Idaho Springs, 1 (KU); Camp Lemon, above Silverplume, 1 (DMNH). PITKIN COUNTY: Thomasville, 1 (WC); 2 mi. SW Aspen, 8175 ft., 2 (CU). LAKE COUNTY: Halfmoon Creek, 8 mi. SW Leadville, 10,000 ft., 4 (KU); *Halfmoon Creek, 11 mi. SW Leadville, 12,000 ft.*, 6 (KU). GUNNISON COUNTY: Virginia Basin, near Gothic, 1 (UNM); Crested Butte Peak, 9500 ft., 1 (WC); Spring Creek, Cochetopa [Gunnison] National Forest, 3 (USNM); *Mill Creek, Cochetopa National Forest*, 1 (USNM). CHAFFEE COUNTY: St. Elmo, 2 (USNM).

Additional records: EAGLE COUNTY: McCoy (A. H. Howell, 1929:82, as *quadrivittatus*). GUNNISON COUNTY (Long and Cronkite, 1970:290): *Avery Flats, Mount Avery, 10,600 ft.; Taylor Canyon, 16 to 20 mi. [N]E Almont, about 8500 ft.;* Tomichi Dome, 9700-10,500 ft.

Marmota flaviventris

Yellow-bellied Marmot

Marmota flaviventris ranges throughout the mountainous sections of Colorado, wherever areas of broken rock provide shelter and green herbage is available for summer food. Extremes of altitudinal range of specimens examined are Bingham Hill, 5 mi. NW Fort Collins, about 5400 feet, and 1/2 mi. below the summit of Pikes Peak, 13,760 feet.

It is unlikely that the range of the yellow-bellied marmot has been altered significantly by human intervention. Local populations have been reduced by hunting for "sport" and as an emergency food item. Warren (1916: 296) noted that "woodchucks" were decimated by striking coal miners at Crested Butte in 1915. Recovery is rapid when molestation ceases. Marmots are adaptable to cultural novelties in their environment. In the late autumn of 1964, a bridge of hollow-cored concrete slabs was constructed across Elkhorn Creek, southwest of Log Cabin, Larimer County. By early June, 1965, the tiles forming the core of the slabs were occupied by a pair of marmots, evidently emigrants from an established colony in a rockpile adjacent to a meadow some 100 yards distant. The rock facing of a dam was cover for several marmots along the North Fork of Michigan River, northwest of Gould, Jackson County, in 1968. The immediate area of the damsite had previously been marginal habitat for the species. Marmots may become a nuisance in or beneath unoccupied buildings.

The biology of marmots has been studied in detail by Armitage (1962, 1965), Armitage and Downhower (1970), Shirer and Downhower (1968), and Downhower and Pauley (1970). Parts of these studies were conducted near Gothic, Gunnison County. Marmot vocalizations were described by Warren (1935b) and Waring (1966a). Possible dwarfism among Coloradan marmots was discussed by Warren (1926b) and chromosomes of *M. flaviventris* were described by Hoffmann and Nadler (1968).

Marmota flaviventris luteola A. H. Howell

Marmota flaviventer luteola A. H. Howell, Proc. Biol. Soc. Washington, 27:15, 2 February 1914; type locality, Woods Post Office [now Woods Landing], Medicine Bow Mountains, Albany Co., Wyoming.

Marmota flaviventer warreni A. H. Howell, Proc. Biol. Soc. Washington, 27:16, 2 February 1914; type locality, [2 mi. W] Crested Butte, 10,000 ft., Gunnison Co., Colorado (regarded as inseparable from *M. f. luteola* by Warren, 1936:396).

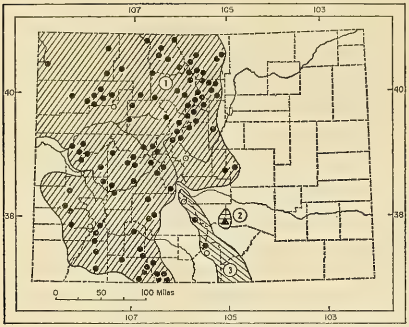


FIG. 43. Distribution of *Marmota flaviventris* in Colorado. 1. *M. f. luteola*. 2. *M. f. notioros*. 3. *M. f. obscura*. For explanation of symbols, see p. 9.

Marmota flaviventer campioni Figgins, Proc. Biol. Soc. Washington, 28:147, 21 September 1915; type locality, detached range between North Fork and North Platte River, 8 mi. N[W] Higho, Jackson Co., Colorado (regarded as inseparable from *M. f. luteola* by Warren, 1936:396).

Distribution in Colorado.—Mountains of central and western parts of state (Fig. 43).

Comparisons.—From *M. f. obscura*, the subspecies of the Sangre de Cristo Range, *M. f. luteola* differs in generally paler, more buffy coloration, and more prominent white facial markings. From *M. f. notioros*, the subspecies of the Wet Mountains, *M. f. luteola* differs in paler, more buffy coloration, and relatively shorter, broader skull.

Measurements.—External measurements of two males, followed by those of three females, from Gunnison County, are: 640, 654, 660, 620, 625; 183, 175, 198, 177, 206; 89, 90, 80, 81, 80. External measurements of two males and a female from the vicinity of Norwood, San Miguel County, are: 651, 681, 635; 197, 191, 194; 86, 87, 83. Three females from Irwin, Gunnison County, weighed 7 3/4, 8 3/4, and 9 3/4 pounds. Selected cranial measurements are listed in table 10.

Remarks. — North American species of *Marmota* were revised by A. H. Howell (1915). Four subspecies of *M. flaviventris* were recognized in Colorado. Figgins (1915) named a fifth subspecies from the state. Warren (1936) reviewed the taxonomy of Coloradan marmots, concluding that *M. f. warreni* Howell and *M. f. campioni* Figgins both were inseparable from *M. f. luteola*.

Marmota f. warreni was characterized by large size and deep reddish color. A. H. Howell (1915:53) relegated to the subspecies specimens from Crested Butte, Mud Springs, 9 mi. S of Cochetopa Pass, and Sapinero.

I concur with Warren (1936) that, on the basis of material now available, marmots from west-central Colorado do not seem to warrant subspecific recognition. Further knowledge of marmots in southeastern Utah could necessitate revision of that opinion, however, as Durrant (1952:105) suggested. Were a suitably large number of skins of similar age and comparable pelage available, a generally clinal tendency toward darker color probably would be recognizable from northeast to southwest in the state. The available material strongly suggests such a cline. Nonetheless, probably the darkest marmot examined by me was an adult male (DMNH 1458) from Dixie Lake, in the Front Range near Corona Pass.

The name *campioni* apparently was based on two specimens from Jackson County in the Denver Museum of Natural History—the holotype (DMNH 1235) from northwest of Higho, and a second individual (DMNH 1234) from Boettcher Ranch, near Lake John. The race was characterized primarily by the presence of pronounced white facial markings, extending to the head and throat. The holotype is a young adult, with no visible wear on the permanent dentition, save on the third molars. Sutures of the skull are open (basisphenoid), or not yet ankylosed; external measurements of this individual are 670, 180, 83.

As asserted by Warren (1936), subspecific recognition of marmots from the range of hills east of the Park Range near Lake John seems to be inappropriate. White facial markings are apparent in nearly all specimens of *flaviventris* from central Colorado, varying perhaps with age. The holotype of *M. f. campioni* appears to represent an extreme instance, but a specimen (WC 8222) from La Manga Pass, Conejos County, is similarly marked, and an individual (KU 14851) from 1 mi. W Woods Landing (near the type locality of *luteola*), Albany County, Wyoming,

TABLE 10

Selected cranial measurements of three subspecies of *Marmota flaviventris*.

Number averaged (or catalog number), sex	Condylobasal length	Palatal length	Zygomatic breadth	Length of nasals	Mastoid breadth	Interorbital constriction	Length of maxillary toothrow
Marmota flaviventris luteola, western Jackson County							
DMNH 1235, ♂ (young adult)	82.8	——	54.6	35.6	39.7	16.1	21.1
KU 19960, ♀	84.2	41.5	55.4	34.2	40.9	19.7	20.3
1 mi. N Craig, Moffat County							
KU 29128, ?	99.7	49.5	66.1	41.2	49.0	21.2	22.5
Grand Mesa, Mesa and Delta counties							
KU 59731, ♂	87.5	43.3	59.7	36.4	41.4	18.7	21.2
KU 70022, ♂	86.6	42.1	56.7	36.9	41.5	19.5	20.3
KU 59733, ♀	81.7	40.3	54.8	34.9	39.3	19.9	21.1
Gunnison County							
WC 8192, ♂	93.1	43.6	61.5	39.5	42.7	20.5	19.8
WC 8188, ♂	88.7	43.7	56.4	38.7	40.8	17.4	21.6
Mean, 5 ♀	87.08	41.90	57.98	36.60	42.08	19.20	20.36
Minimum	83.5	40.4	56.8	34.6	40.5	17.1	18.9
Maximum	89.2	42.8	59.2	39.7	44.7	21.1	21.4
vicinity of Norwood, Montrose and San Miguel counties							
SC 476, ♂	92.6	45.6	58.0	40.3	42.7	19.9	21.6
SC 938, ♂	87.8	42.5	54.9	36.5	40.8	18.0	21.7
WC 8231, ♀	83.1	42.4	53.8	36.4	39.2	19.1	20.3
SC 886, ♀	84.5	42.2	54.9	36.8	40.2	18.0	20.1
Mineral County							
WC 8200, ♂	91.7	44.5	59.2	39.3	43.6	21.3	21.5
WC 8197, ♀	87.8	43.2	58.0	38.6	41.5	19.7	21.1
KU 41643, ♀	94.1	45.6	59.7	41.5	43.8	21.9	22.3
Marmota flaviventris notioros, Marion Reservoir, Custer County							
WC 4309, ♂	90.1	43.7	59.2	37.2	43.4	19.8	22.2
WC 4310, ♀	88.5	42.6	61.0	37.9	43.2	20.1	20.1
Marmota flaviventris obscura, vicinity of Venable Lake, *in* Saguache County							
WC 4348, ♀	87.9	——	56.1	38.6	40.7	20.2	20.5
WC 4349, ♀	——	——	59.7	37.8	43.2	21.9	20.2

has extensive white markings on the muzzle extending to the throat and crown.

Marmots from northeastern Utah were referred by Durrant (1952:102) to *M. f. nosophora*, the subspecies of the Northern Rocky Mountains. In Wyoming, *luteola* apparently differs from *nosophora* in slightly smaller external and cranial size and more yellowish (less reddish) color (Long, 1965:570-571). On geographic grounds, one would expect to find intergradation between *luteola* and *nosophora* in extreme western Moffat County. A single specimen is available from the area in question, an immature male from Dinosaur National Monument, east of the Green River. The specimen is indistinguishable externally from individuals of comparable age from Axial Basin and from Boulder County, and is herein referred to *M. f. luteola*. Material is needed from that portion of Moffat County that lies west of the Green River to describe adequately the relationships between *luteola* and *nosophora* in this area.

Records of occurrence.—Specimens examined, 272, distributed as follows: MOFFAT COUNTY: 16 mi. N Craig, 2 (KU); Castle Park, 1/2 mi. from mouth of Hell's Canyon, Dinosaur National Monument, 1 (CU); Hamilton, 1 (CM). ROUTT COUNTY: Elkhead Mountains, 1 (USNM); 18 mi. below Steamboat Springs, 6550 ft., 2 (WC); Toponas, 4 (DMNH). JACKSON COUNTY: 4 mi. NW Northgate, 1 (DMNH); *Northgate,* 1 (DMNH); 15 mi. SW Pearl, 9500 ft., 1 (CSU); 8 mi. N Higho, 1 (DMNH); *Boettcher Ranch, Lake John,* 1 (DMNH); near Lake John, 8500 ft., 1 (WC); *2 mi. N, 9 1/2 mi. W Walden, 8400 ft.,* 5 (KU); Walden, 2 (DMNH); 2 mi. N, 2 mi. W Gould, 8600 ft., 2 (KU). LARIMER COUNTY: Bingham Hill, 5 mi. NW Fort Collins, 1 (CSU); *1/8 mi. W Crown Point, 10,500 ft.,* 1 (CSU); Crown Point, 11,000 ft., 1 (CSU); 10 mi. W Fort Collins, 1 (CSC); Trap Lake, 1 (UNM); *Rocky Mountain National Park,* 1 (UMMZ); Willow Park, 1 (UMMZ); Fall River Pass, 11,700 ft., 1 (RMNP); *1 mi. E Fall River Pass,* 1 (RMNP); *Trail Ridge Road,* 5 (RMNP); *Trail Ridge Road, near Rock Cut,* 3 (RMNP); *Trail Ridge Road, below Upper Hidden Valley,* 1 (RMNP); Estes Park, 3 (1 AMNH, 1 CSU, 1 USNM); *Big Thompson River Entrance, Rocky Mountain National Park,* 1 (RMNP); *Bear Lake Road,* 1 (RMNP); Longs Peak, 1 (USNM); *no locality other than county,* 2 (CSU). RIO BLANCO COUNTY: 7 mi. NE Meeker, 1 (CM); *6 mi. NE Meeker,* 1 (CM); Meeker, 2 (WC); Little Hills Experiment Station, 1 (CSU); Ute Creek, 8000 ft., 1 (AMNH); Dry Fork, White River, 6400 ft., 24 (AMNH); 13 mi. SW Meeker, 1 (CSU); *North Fork, White River, 6000 ft.,* 1 (AMNH); Mud Springs, 8800 ft. [county line, due N of Silt], 5 (WC); *Compass Creek, 9000 ft.* (not found), 4 (AMNH). GARFIELD COUNTY: 5 mi. E Glenwood [Springs], 1 (FMNH). EAGLE COUNTY: 20 mi. SW Toponas, 2 (DMNH); 19 mi. E Wolcott, 1 (WC). GRAND COUNTY: Timber Creek Campground, Rocky Mountain National Park, 1 (RMNP); Phantom Canyon, 1 (RMNP); Rabbit [Ears] Pass, 1 (FMNH); Hot Sulphur Springs, 7665 ft., 7 (1 AMNH, 1 USNM, 5 WC); *Middle Park,* 1 (USNM); Sheephorn Pass, 8000 ft., 1 (WC); *near Sheephorn Pass, 8200 ft.,* 1 (WC); Berthoud Pass, 1 (DMNH). SUMMIT COUNTY: Dillon, 1 (UI); Hoosier Pass, 2 (DMNH). BOULDER COUNTY: 14 mi. W Lyons, 1 (WC); near Lyons, 6650 ft., 1 (RMNP); Lefthand Canyon, 1 (CU); Arapahoe Peak, 2 (1 CU, 1 FMNH); Silver Lake, 10,000 ft., 4 (1 CU, 2 DMNH, 1 FMNH); Boulder, 1 (CU); *Flagstaff Mountain,* 2 (CU); *Gregory Canyon,* 1 (FWS); *Corona,* 1 (DMNH); Dixie Lake, 1 (USNM); *no locality other than county,* 2 (USNM). GILPIN COUNTY: Jenny Lake, near Tolland, 1 (CU). CLEAR CREEK COUNTY: Silverplume, 11,000 ft., 3 (1 DMNH, 2 SC); Loveland Pass, 11,992 ft., 1 (SC); *Echo Lake,* 4 (DMNH); Mount Evans, 12,000 ft., 6 (5 DMNH, 1 FMNH). JEFFERSON COUNTY: North Turkey Creek, 1 (DMNH). MESA COUNTY: Mesa, 1 (FMNH); Palisade, 1 (FMNH); Grand Mesa, 28 mi. E Grand Junction, sec. 29, T. 11 S, R. 95 W, 1 (KU). PITKIN COUNTY: Hunters Creek, near Aspen, 2 (DMNH); Independence Pass, 1 (FMNH). LAKE COUNTY: 13 mi. SW Leadville, 12,500 ft., 1 (KU). PARK COUNTY: Call [Hall] Valley, 2 (DMNH); Mount Lincoln, 4 (MCZ); *S slope of Mount Lincoln, 12,500 ft.,* 1 (WC); *Montgomery,* 5 (MCZ); Buckskin Ridge, near Alma, 1 (WC); *Kite Lake, Buckskin Gulch,* 1 (AMNH). DELTA COUNTY: 9 mi. S, 3 mi. E Collbran, 10,200 ft., 1 (KU); *6 mi. E Skyway, 10,000 ft.,* 1 (KU); *6 mi E Skyway, 10,500 ft.,* 1 (KU); *1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 1 (KU); 4 mi. S, 4 mi. E Skyway, 9500 ft., 2 (KU); Hotchkiss, 1 (FMNH). GUNNISON COUNTY: Muddy Creek, about 16 mi. above mouth, 4 (WC); Mount Baldy, 1 (UMMZ); *Copper Creek, 1 mi. NE Gothic,* 1 (KU); *Gothic,* 1 (USNM); *Pittsburgh,* 3 (WC); Irwin, 11,500 ft., 3 (WC); *Irwin Road, half-way between Coon Creek and Iron Swamp,* 1 (WC); *Pittsburgh Road, 1 mi. above Crested Butte,* 1 (WC); Illinois Creek, Taylor Park, 8 (WC); Crested Butte, 9000 ft., 6 (1 KU, 5 WC); *Brush Creek,* 1 (MCZ); Tincup, 1 (DMNH); Ohio Creek, 6 mi. N Gunnison, 1 (WSC); Mesa Creek, Black Mesa, 3 (WC); *Black Mesa, 25 mi. SE Crawford, 10,000 ft.,* 1 (CSC); Sapinero, 1 (USNM). CHAFFEE COUNTY: Cottonwood Pass Road, 11,500 ft., 1 (WC); Monarch Park, 10,728 ft., 2 (WC). EL PASO COUNTY: Pikes Peak, 1 (WC); *1/2 mi. below summit of Pikes Peak, 13,760 ft.,* 1 (WC); Colorado Springs, 1 (FWS). MONTROSE COUNTY: Maher, 4 (WC); near Columbine Pass, 2 (WC); Redvale, 1 (SC). OURAY COUNTY: *Red Mountain, 10,500 ft.,* 1 (AMNH); Red Mountain Pass, 3 (2 SC, 1 WC); *near Red Mountain Pass,* 3 (WC). SAN MIGUEL COUNTY: Norwood, 1 (SC); Lone Cone, 1 (SC). SAGUACHE COUNTY: 8 mi. above Parlin, 1 (WC); Cochetopa Pass, 1 (USNM); 10 mi. S Cochetopa Dome, 1 (CSU). SAN JUAN COUNTY: Molas Pass, 1 (WSC); 25 mi. from Silverton, toward Durango, 1 (WC). MINERAL COUNTY: above Creede, 1 (WC); 25 mi. S, 9 mi. E Creede, 10,000 ft., 1 (KU); 5 mi. N Wolf Creek Pass, 1 (CU); *near Wolf Creek Pass Road, 11,500 ft.,* 2 (WC); *Wolf Creek Pass Road, 10,800 ft.,* 2 (WC). LA PLATA COUNTY: Cascade Siphon, 1 (WC); Florida, 1 (AMNH). ARCHULETA COUNTY: Gordon Creek, near junction with Piedra River, 1 (UNM); headwaters Navajo River, 1 (DMNH); Upper Navajo River, 3 (DMNH); Navajo River, 1 (DMNH). CONEJOS COUNTY: "3-5 mi. SW Platoro," 2 (FHSC); 12 mi. NE Cumbres, 1 (AMNH); La Manga Pass, 2 (WC); *2 mi. NE Cumbres,* 1 (AMNH); Cumbres, 1 (CU); *4 mi. S, 23 mi. W Antonito,* 1 (KU); Osier, 10 (DMNH).

Additional records: JACKSON COUNTY: *[near] Lake Agnes* (Yeager, 1950:329). GARFIELD COUNTY (Felger, 1910:143): Marvine Lodge; *Marvine Lakes.* GRAND COUNTY: *3 mi. SW Rabbit*

Ears Pass (Vaughan, 1969:53). BOULDER COUNTY: *Isabell [sic] Glacier Cirque* (Hoffmann and Nadler, 1968). CLEAR CREEK COUNTY: *Georgetown* (Coues and Yarrow, 1875:123). PARK COUNTY: Trout Creek (Allen, *in* Coues and Allen, 1877:921). GUNNISON COUNTY (Findley and Negus, 1953:237, unless otherwise noted): *Copper Lake Basin, 3 8/10 mi. NE Gothic, 11,300 ft.; 3 1/2 mi. NW Gothic; 3 1/10 mi. NE Gothic; 1 mi. ENE Gothic, 10,000 ft.; 7/10 mi. NNE Gothic, 10,500 ft.; Jointed Rod Resort, Gunnison River, 7530 ft.* (Durrant and Robinson, 1962:246); *West Elk Creek, 1 mi. N Gunnison River, 7400 ft.* (Durrant and Robinson, *loc. cit.*); *Dry Gulch at Gunnison River, 7400 ft.* (Durrant and Robinson, *loc. cit.*). SAN MIGUEL COUNTY: Ophir (V. Bailey, 1932:133).

Marmota flaviventris notioros Warren

Marmota flaviventris notioros Warren, Jour. Mamm., 15:62, 15 February 1934; type locality, near Marion Reservoir, about 10,600 ft., Wet Mountains, Custer Co., Colorado.

Distribution in Colorado.—Known only from the type locality; to be expected throughout Wet Mountains of Custer, Pueblo, and Huerfano counties (Fig. 43).

Comparisons.—From *M. f. obscura,* the subspecies of the Sangre de Cristo Range, *M. f. notioros* differs in slightly paler (more reddish) pelage, more extensive white facial markings, and relatively longer, narrower skull. For comparison with *M. f. luteola,* see account of that subspecies.

Measurements.—External measurements of the holotype, a male (WC 4309), and a female topotype (WC 4310) are, respectively: 652, 641; 210, 200; 97, 84; weights, 6 7/8, 7 3/4 pounds. Cranial measurements are listed in table 10.

Remarks.—Although this subspecies is known from only two specimens, available material suggests that it is distinct from other named kinds of marmots. The Wet Mountains are sufficiently isolated to severely restrict gene flow between the indigenous population of marmots and populations to the north and west. Intergradation with other subspecies of *M. flaviventris* has not been demonstrated.

Marmots apparently are not abundant in the Wet Mountains. In the summer of 1969, efforts to secure specimens in the vicinity of the type locality were in vain.

Records of occurrence.—Specimens examined, 2, as follows: CUSTER COUNTY: Marion Reservoir, 10,600 ft., 2 (WC).

Marmota flaviventris obscura A. H. Howell

Marmota flaviventer obscura A. H. Howell, Proc. Biol. Soc. Washington, 27:16, 2 February 1914; type locality, Wheeler Peak, 11,300 ft., 5 mi. S Twining, Taos Co., New Mexico.

Distribution in Colorado.—Sangre de Cristo Range (Fig. 43).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those races.

Measurements.—External measurements of a male and two females from the Sangre de Cristo Range above Crestone are, respectively: 674, 648, 625; 188, 160, 154; 88, 88, 82; 32, 31, 28; weights, 9, 9 3/8, 9 3/8 pounds. Cranial measurements are presented in table 10.

Remarks.—Howell (1915:54) referred specimens from Osier, Archuleta County, and Florida, La Plata County, to *M. f. obscura,* noting that certain specimens from Osier were ". . . considerably paler than in the typical form," and that the reddish color of the single specimen from Florida indicated ". . . apparent intergradation with *warreni.*" I agree with Warren (1942:114) that these specimens represent *luteola,* and that *obscura* is limited, at least in Colorado, to the Sangre de Cristo Range. Records cited by Howell (1915:55) and by Bailey (1932:131) indicate a similar restriction in New Mexico.

Records of occurrence.—Specimens examined, 6, distributed as follows: SAGUACHE COUNTY: Venable Lakes Trail, 2 (WC); *Comanche Lake Trail,* 1 (WC). CUSTER COUNTY: *below Horseshoe Lake,* 1 (WC). ALAMOSA COUNTY: *SW of Blanca Peak, 12,300 ft.,* 1 (WC); Como Lake, 11,500 ft., 1 (WC).

Additional records: SAGUACHE COUNTY: ". . . very rare at the head of Raspberry Creek, northerly from Villa Grove" (Warren, 1942:114). COSTILLA COUNTY: "Fort Massachusetts [probably from Sierra Blanca Peak]" (A. H. Howell, 1915:55); *[near] Fort Garland* (Coues and Yarrow, 1875:123).

Ammospermophilus leucurus

WHITE-TAILED ANTELOPE SQUIRREL

The white-tailed antelope squirrel is an inhabitant of semidesert valleys and plateaus of western Colorado, ranging to an elevation of about 7000 feet. The squirrels are solitary and burrow extensively beneath trees, shrubs, or rocks. Population densities seem to remain

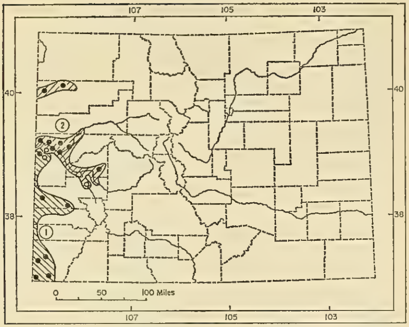


FIG. 44. Distribution of *Ammospermophilus leucurus* in Colorado. 1. *A. l. cinnamomea.* 2. *A. l. pennipes.* For explanation of symbols, see p. 9.

generally low. Although McCoy and Miller (1964) reported on the distribution of *Ammospermophilus leucurus* in Colorado, details of its natural history have not been investigated.

Ammospermophilus leucurus cinnamomeus (Merriam)

Tamias leucurus cinnamomeus Merriam, N. Amer. Fauna, 3:52, 11 September 1890; type locality, Echo Cliffs, Painted Desert, Coconino Co., Arizona.

Ammospermophilus leucurus cinnamomeus, Mearns, Bull. U.S. Nat. Mus., 56:299, 13 April 1907.

Distribution in Colorado. — Southwestern part of state, typically above 5500 feet (Fig. 44).

Comparison. — From *A. l. pennipes,* the subspecies to the north in Colorado, *A. l. cinnamomeus* differs in slightly smaller average cranial dimensions and more vinaceous color.

Measurements.—External measurements of three females from Four Corners are: 223, 229, 222; 66, 72, 82; 40, 39, 39. External measurements of a male and two females from Bedrock, Montrose County, are: 213, 230, 224; 56, 70, 60; 40, 43, 41. Selected cranial measurements are presented in table 11.

Remarks.—McCoy and Miller (1964) reviewed the distribution of Coloradan subspecies of *A. leucurus* (see remarks in the account of *A. l. pennipes,* below). The characters by which these two subspecies are differentiated are fairly subtle and large series of specimens of similar age and taken at comparable seasons will be necessary before the extent of variation in the populations can be fully appreciated.

McCoy and Miller (*op. cit.*:93) referred specimens from Bedrock to *A. l. pennipes.* Direct comparison was made by me of skins from Bedrock with topotypes of *pennipes* from Grand Junction and specimens of *cinnamomeus* from Montezuma County. To my eye, material from Bedrock more closely resembles the latter population. An old female (WC 2993) from Bedrock has the general appearance of *pennipes* where the pelage is worn, but was molting in patches to a pelage like that of *cinnamomeus.*

Records of occurrence.—Specimens examined, 20, distributed as follows: MESA COUNTY: Sieber Ranch, Little Dolores Creek, 1 (WC). MONTROSE COUNTY: Bedrock, 8 (3 AMNH, 5 WC); 7 mi. W Naturita, 1 (CSU); Coventry, 1 (USNM). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 3 (1 USNM, 2 WC); 2 mi. S, 24 mi. W Cortez, 4850 ft., 1 (KU); Mancos River, 1/2 mi. N Colorado-New Mexico boundary, 1 (DMNH); Four Corners, 4 (DMNH).

Additional record: MESA COUNTY: Rim Rock Drive at Coke Ovens, Colorado National Monument (McCoy and Miller, 1964:93).

Ammospermophilus leucurus pennipes A. H. Howell

Ammospermophilus leucurus pennipes A. H. Howell, Jour. Mamm., 12:162, 14 May 1931; type locality, Grand Junction, Mesa Co., Colorado.

Distribution in Colorado. — West-central part of state in valleys of Colorado River and tributaries, generally below 5500 feet (Fig. 44).

Comparison.—For comparison with *A. l. cinnamomeus,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of six males, followed by those of six females, all from the Grand Valley of the Colorado River, are: 226.2 (213-239), 224.3 (217-231); 65.8 (57-74), 65.2 (60-68); 39.3 (38-41), 39.0 (38-40). Selected cranial measurements are presented in table 11.

Remarks.—Warren (1942:133) stated that his description of *A. l. cinnamomeus* was based on a specimen taken at Grand Junction —the type locality of *A. l. pennipes.* Hall and Kelson (1959:332) perpetuated this *lapsus,* listing Grand Junction as a marginal record

TABLE 11

Selected cranial measurements of six species of ground squirrels (genera *Ammospermophilus* and *Spermophilus*).

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Postorbital constriction	Length of nasals	Condyloalveolar length of mandible	Length of maxillary toothrow
Ammospermophilus leucurus cinnamomeus, Bedrock, Montrose County							
WC 2944, ♂	40.9	38.5	23.8	13.6	12.1	21.9	7.8
WC 2955, ♀	40.6	38.5	24.4	14.1	12.6	22.4	7.5
WC 2977, ♀	41.2	39.1	24.0	14.8	12.7	22.9	7.2
Montezuma County							
WC 1455, ♀	40.9	38.8	23.8	12.7	12.6	22.4	7.5
DMNH 740, ♀	40.0	37.3	22.6	13.6	12.4	——	7.2
Ammospermophilus leucurus pennipes, Grand Valley of Colorado River, Mesa County							
Mean, 6 ♂	40.63	38.63	23.63	13.87	12.28	22.60	7.32
Minimum	40.1	37.7	22.7	13.3	11.2	21.7	7.1
Maximum	41.9	39.5	24.2	14.7	13.0	23.4	7.5
Mean, 6 ♀	40.30	38.25	23.58	13.80	12.05	22.33	7.43
Minimum	39.3	37.6	23.1	13.0	11.6	21.9	7.1
Maximum	40.9	38.6	24.1	14.4	12.5	22.7	7.7
Spermophilus spilosoma cryptospilotus, Ackmen, Montezuma County							
FMNH 48132, ♂	37.2	34.4	——	12.7	12.8	20.6	6.8
FMNH 48131, ♀	37.5	35.3	23.1	12.7	——	18.3	6.9
Spermophilus spilosoma marginatus, Las Animas, Bent County							
USNM 47345, ♂	42.6	39.4	25.5	13.8	14.5	22.6	8.0
USNM 47347, ♂	41.5	38.5	24.9	14.8	14.1	22.7	8.0
USNM 47341, ♀	41.5	39.2	24.8	14.8	14.4	22.4	8.2
USNM 47243, ♀	40.8	38.6	24.5	13.5	13.6	22.1	7.7
USNM 47348, ♀	40.0	37.7	24.2	13.6	14.0	21.8	8.0
Spermophilus spilosoma obsoletus, Weld and Adams counties							
DMNH 2266, ♂	43.0	39.9	——	13.3	15.3	22.9	7.8
DMNH 2269, ♂	41.3	38.6	——	13.1	14.5	22.5	7.8
DMNH 2270, ♀	41.5	39.0	——	13.2	14.3	22.8	7.5
CU 1621, ♀	39.8	36.7	23.3	14.1	14.2	21.3	7.5
Spermophilus richardsonii elegans, Larimer County							
KU 8790, ♂	43.1	40.0	25.8	10.4	15.4	25.8	9.6
KU 91083, ♂	45.0	43.7	27.6	9.9	15.9	27.6	9.7
Mean, 11 ♀	44.26	41.75	29.01	10.75	15.70	26.73	10.05
Minimum	42.3	40.1	27.1	10.4	14.9	25.8	9.5
Maximum	46.6	44.5	30.5	12.3	17.4	27.7	10.6
Spermophilus tridecemlineatus arenicola, Baca County							
Mean, 12 ♂	39.26	37.17	23.94	11.62	13.96	21.89	7.35
Minimum	38.2	35.6	23.0	11.0	13.0	20.5	6.8
Maximum	40.8	39.3	24.7	12.6	14.8	23.0	7.6
Mean, 4 ♀	39.53	36.87	23.32	11.52	13.83	21.72	7.55
Minimum	38.9	36.3	22.7	11.4	13.2	21.0	7.4
Maximum	40.1	38.2	24.2	11.7	14.5	22.0	7.8

TABLE 11 (Continued)
Selected cranial measurements of six species of ground squirrels (genera *Ammospermophilus* and *Spermophilus*).

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Postorbital constriction	Length of nasals	Condyloalveolar length of mandible	Length of maxillary toothrow
Spermophilus tridecemlineatus blanca, San Luis Valley							
WC 4135, ♂	36.7	34.1	21.2	11.5	12.1	20.1	6.0
Mean, 5 ♀	35.85	33.36	20.76	10.96	11.90	19.02	6.64
Minimum	35.4	32.6	20.1	10.5	11.5	18.7	6.5
Maximum	36.6	34.3	21.6	11.6	12.6	19.5	6.8
Spermophilus tridecemlineatus pallidus, Larimer and Weld counties							
Mean, 7 ♂	40.33	37.41	23.63	11.30	14.30	22.13	7.43
Minimum	38.4	35.9	23.0	10.6	13.8	20.8	7.3
Maximum	41.0	37.9	24.1	11.9	14.7	22.8	7.8
Mean, 8 ♀	39.23	36.70	23.36	11.25	13.71	21.86	7.34
Minimum	38.4	35.6	22.2	10.9	13.0	21.2	7.0
Maximum	40.0	38.1	24.3	11.6	14.6	23.1	7.7
Spermophilus tridecemlineatus parvus, Moffat County							
CU 5380, ♂	35.5	32.7	20.0	10.8	11.8	18.6	6.8
DMNH 2046, ♂	35.6	33.2	20.7	11.7	11.8	19.3	6.3
DMNH 2055, ♀	34.8	32.2	19.8	11.2	11.1	18.9	6.5
White River Plateau							
WC 2538, ♂	34.2	31.9	20.1	11.1	10.6	18.4	6.1
WC 2520, ♀	34.3	32.1	20.0	10.4	10.9	18.7	6.3
WC 2527, ♀	34.8	32.3	19.9	11.1	10.9	18.3	6.3
Spermophilus variegatus grammurus, Las Animas and Baca counties							
Mean, 5 ♀	60.56	57.42	37.38	17.06	21.52	35.57	12.12
Minimum	57.6	54.7	35.6	16.2	20.1	33.4	11.7
Maximum	63.5	59.7	39.1	17.8	22.7	37.6	12.7
Montrose and Montezuma counties							
AMNH 27427, ♂	60.8	58.0	37.6	16.7	22.6	35.0	12.1
AMNH 28904, ♂	62.9	59.8	39.6	17.3	23.1	35.1	12.3
AMNH 27426, ♀	58.3	55.5	—	18.0	20.8	34.0	11.9
AMNH 28905, ♀	59.5	56.5	36.0	17.0	21.6	35.1	12.2
AMNH 28906, ♀	60.6	57.5	37.1	17.2	21.7	35.3	11.9
Spermophilus lateralis lateralis, Larimer and Boulder counties							
Mean, 5 ♂	43.58	40.53	27.04	12.66	15.60	25.02	8.42
Minimum	43.2	40.0	26.3	12.1	14.6	24.6	7.9
Maximum	44.8	41.0	27.6	13.3	16.5	25.5	8.9
Mean, 9 ♀	43.53	40.53	26.99	12.44	15.40	24.92	8.48
Minimum	42.8	39.2	25.8	11.9	14.4	24.4	8.0
Maximum	44.1	41.6	27.9	12.9	16.0	25.5	8.7

for *cinnamomeus.* Fruita was listed (*op. cit.*: 333) as an eastern marginal record for *pennipes,* thus effectively excluding the type locality of *pennipes* from the range of that subspecies. It was in view of this confused situation that McCoy and Miller (1964) reviewed the subspecies of *A. leucurus* in western Colorado. They concluded that there are ecological as well as morphological differences between the two recognized subspecies. *Ammospermophilus l. pennipes* generally occurs below 5500 feet in river valleys, where the predominant vegetation is an association of *Atriplex, Artemisia,* and *Sarcobatus* growing on heavy soils. Rock outcrops and river-sorted boulder fields are preferred habitat. North of the Grand Valley, *pennipes* may occur above 5500 feet, but in those places it still is characteristically restricted to semidesert valleys. *Ammospermophilus l. cinnamomeus,* on the other hand, occurs from 5500 feet to about 7000 feet on uplands, inhabiting sandy soils of openings in the piñon-juniper woodland. In extreme southwestern Colorado, this subspecies occurs at somewhat lower elevations and in situations comparable to those occupied by *pennipes* farther north.

Durrant (1952:122, map) implied that the Colorado River formed the boundary between the two subspecies in eastern Utah, but this is not the case in Colorado, since *pennipes* occur south of the river at lower elevations.

Records of occurrence.—Specimens examined, 67, distributed as follows: RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 2 (USNM); Douglas Creek, 3 mi. S Rangely, 1 (CM). MESA COUNTY: *U.S. Highway 50, 30 mi. E Utah state line,* 6 (AMNH); Mack, 3 (WC); Stateline, 6 (CM); 10 mi. N Grand Junction, 1 (CU); Cameo, 1 (WC); Fruita, 1 (USNM); *2 1/2 mi. S Fruita,* 2 (KU); *Fruita Reservoir No. 1,* 1 (CNM); *3/4 mi. above Fruita Entrance, Colorado National Monument,* 2 (CNM); Grand Junction, 38 (1 CSU, 1 CU, 1 DMNH, 7 FMNH, 1 MCZ, 21 USNM, 6 WC). DELTA COUNTY: Hotchkiss, 5300 ft., 2 (USNM).

Additional records (Warren, 1942:135, unless otherwise noted): MESA COUNTY: *Palisade; 7 mi. S Carbonera* (McCoy and Miller, 1964:93); *mouth of Monument Canyon, Colorado National Monument* (McCoy and Miller, *loc. cit.*). DELTA COUNTY: *"nearly to Paonia."* MONTROSE COUNTY: Montrose.

Spermophilus richardsonii

RICHARDSON'S GROUND SQUIRREL

Richardson's ground squirrel is an inhabitant of sage plains and grasslands at elevations from about 5000 feet to above timberline, and may be abundant locally. Openings in montane forest only a few acres in extent are suitable for colonization. When established on rangelands or near cultivated areas, populations may do considerable damage. The extensive efforts to control numbers of *Spermophilus richardsonii* and to check their spread in Colorado were discussed by W. L. Burnett; the interested reader is directed to the Circulars and Annual Reports of the State Entomologist of Colorado, beginning in 1912, and to Burnett (1930a). Burnett (1916b, 1920, 1931) discussed the natural history of *S. richardsonii* in Colorado in detail.

More recent research on the biology of Richardson's ground squirrel in the Laramie Basin of southern Wyoming was discussed by Clark (1968a, 1970) and Clark and Denniston (1970). Hansen and Reed (1969) reported work on energy assimilation in Coloradan *S. richardsonii,* and Gerber and Birney (1968) studied immunological reactions of the species and several other Coloradan ground squirrels. Nadler (1968) reported on serum proteins and transferrins.

Populations of *S. richardsonii* were affected by the epizootic of sylvatic plague that decimated prairie dogs (*Cynomys gunnisoni*) in South Park beginning about 1945 (see Ecke and Johnson, 1950, and Fitzgerald, 1969).

The range of *S. richardsonii* in Colorado apparently has expanded remarkably over the past half-century. This dispersal was documented in detail by Hansen (1962b), who cited four major factors contributing to the spread: 1) a lack of absolute physical barriers; 2) favorable distribution of native vegetation; 3) absence of natural competitors; and 4) the ability to use burrows of other fossorial rodents, including those of prairie dogs and pocket gophers. Hansen (*op. cit.*:63) noted further that habitat that apparently is suitable extends ". . . in practically all directions from the present range of the Richardson ground squirrel." Further extensions of range are to be expected, particularly in the valleys of the Arkansas and Gunnison rivers. Hansen (*op. cit.*:58) was of the opinion that dispersal was pursuant to geologic events, and not caused by modern man. However, Wright *et al.* (1933:110) saw the invasion of Estes Park by *S. richardsonii* as a consequence of civilization there. Those authors noted, as did Hansen (*op. cit.*:64) that Richardson's ground squirrel tends to displace *Spermophilus lateralis* from meadowlands where the two species are sympatric.

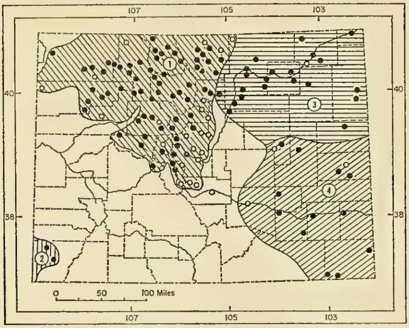


FIG. 45. Distribution of two species of ground squirrels in Colorado. 1. *Spermophilus richardsonii elegans.* 2. *Spermophilus spilosoma cryptospilotus.* 3. *S. s. obsoletus.* 4. *S. s. marginatus.* For explanation of symbols, see p. 9.

Hunt (1954:118) reported *S. richardsonii* from alluvium of Wisconsin (Pinedale) age at Denver.

Spermophilus richardsonii elegans Kennicott

Spermophilus elegans Kennicott, Proc. Acad. Nat. Sci. Philadelphia, 15:158, 1863; type locality, Fort Bridger, Uinta Co., Wyoming.

[Spermophilus richardsoni] var. *elegans,* J. A. Allen, Proc. Boston Soc. Nat. Hist., 16:292, 1874.

Distribution in Colorado.—Mountain parks and valleys in northwestern and north-central parts of state, south to Gunnison, Chaffee, and Fremont counties (Fig. 45, and Hansen, 1962b:59).

Measurements.—External measurements of three males, followed by mean (and extreme) measurements of 10 females, all from Larimer County, are: 256, 280, 274, 281.9 (260-302); 84, 96, 82, 76.8 (62-98); 40, 43, 42, 42.3 (39-46); 10, 10, —, 12.0 (9-16); weights of three females, 244, 340, 240. Selected cranial measurements are presented in table 11.

Remarks.—Hansen (1962b:62) noted that the population of *S. richardsonii* at the Colorado State Prison Farm near Cañon City was disjunct from the conterminous range of the species in the state and may represent an introduced population.

Records of occurrence.—Specimens examined, 280, distributed as follows: MOFFAT COUNTY: Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 2 (DMNH); 8 mi. NE Craig, 12 (CM); 23 mi. W Craig, 6300 ft., 3 (CM); *Fortification Creek, N of Craig,* 5 (UMMZ); Maybell, 2 (UMMZ); 9 mi. SW Craig, 1 (CM); *between Craig and Kelley's* 1 (WC); *no locality other than county,* 1 (CM). ROUTT COUNTY: Steamboat Springs, 7 (1 AMNH, 2 DMNH, 2 USNM, 2 WC); *15 mi. W Steamboat Springs,* 1 (USNM); *Elk River,* 1 (DMNH); 13 mi. below Steamboat Springs, 6600 ft., 3 (WC); 12 mi. below Hayden, 6300 ft., 3 (1 AMNH, 2 WC); 5 mi. below Hayden, 2 (WC); Rabbit Ears Pass, 9680 ft., 1 (CM); Oak Creek, 7200 ft., 1 (WC); *Watson Creek, near Yampa, 7800 ft.,* 2 (WC); 10 mi. W Toponas, 1 (DMNH); *near Toponas, 7800 ft.,* 2 (WC); *near Egeria Pass, 8000 ft.,* 1 (WC); *no locality other than county,* 3 (DMNH). JACKSON COUNTY: near Pearl, 1 (CU); *Independence Mountain,* 2 (DMNH); Canadian Creek, 2 (USNM); *Boettcher Ranch, Lake John,* 16 (3 AMNH, 13 DMNH); Brand's Ranch, Lake John, 8250 ft., 1 (WC); *10 mi. W Walden,* 1 (AMNH); Walden, 8275 ft., 1 (WC); 15 mi. E Walden, 1 (CU); *Humbert Study Area [T. 9 N, R. 80 W],* 1 (CSU); *3 mi. S, 1 mi. E Walden,* 1 (CSU); 7 mi. SW Walden, 1 (CU); Cameron Pass, 10,000 ft., 1 (USNM); Arapaho Pass, 1 (USNM); *Mosman Ranch* (not found), 1 (CSU). LARIMER COUNTY: Livermore, 2 (KU); Red Feather Lakes, 7500 ft., 1 (CSU); *Parvin Lake, 7500 ft.,* 1 (CSU); Lob Cabin, 2 (CU); *2 mi. E Log Cabin,* 1 (WC); Elkhorn, 7500 ft., 1 (USNM); *[near] Elkhorn, 8500 ft.,* 1 (USNM); *Cache la Poudre River, 7500 ft.,* 4 (USNM); *sec. 26, T. 8 N, R. 73 W,* 1 (CSU); Pingree Park, 2 (1 CSU, 1 CU); *1/8 mi. E Pingree Park,* 1 (CU); *Colorado [Roosevelt] National Forest,* 2 (USNM); Fort Collins, 5 (USNM); *Buckhorn Ranger Station,* 1 (USNM); Endovalley Campground, Rocky Mountain National Park, 1 (RMNP); *Horseshoe Park, 9000 ft.,* 1 (AMNH); *2 1/2 mi. N Estes Park,* 1 (CSC); *Deer Ridge,* 1 (RMNP); Estes Park, 4 (2 AMNH, 1 CU, 1 UMMZ); *E of Estes Park,* 1 (RMNP); *1 mi. SE Estes Park,* 1 (CSU); *1 mi. W Beaver Point,* 1 (RMNP); *Moraine Park,* 1 (RMNP); *Utility Area,* 2 (RMNP); *2 mi. SW Estes Park,* 1 (KU); *2 1/2 mi. SW Estes Park,* 1 (KU); *Hallowell Park,* 1 (RMNP); *3 mi. S, 3 mi. W Estes Park,* 1 (KU); *YMCA Camp,* 1 (RMNP); *3 1/2 mi. SW Estes Park,* 15 (KU); *4 mi. SW Estes Park,* 4 (KU); *4 1/2 mi. SW Estes Park,* 7 (KU); *4 mi. S, 2 mi. W Estes Park,* 1 (KU); 3 mi. S, 5 mi. W Loveland, 1 (CSC). RIO BLANCO COUNTY: 5 mi. S, 3 mi. W Pagoda Peak, 8500 ft., 3 (KU); N side White River, 4 mi. N Meeker, 1 (AMNH); *White Rock, 12 mi. from Meeker,* 1 (WC); *6 mi. NE Meeker,* 5 (CM); 5 mi. above Buford, 1 (CU); Big Beaver Creek, 1 (WC); *Ute Creek, 8000 ft.,* 10 (AMNH); 9 mi. S Meeker, between Flag Creek and Grand Hogback, 8 (CM); Piceance Creek, 4 mi. W Rio Blanco, 1 (CU). GARFIELD COUNTY: Carbondale, 1 (FWS). EAGLE COUNTY: 8 mi. E Eagle, 2 (CU); *between Eagle and Wolcott,* 1 (WC); Allenton, 2 (1 AMNH, 1 WC); 6 mi. S Eagle, 2 (CU); Homestake Creek, 1

(FMNH). GRAND COUNTY: Mount Whitley, 8000 ft., 1 (USNM); Shadow Mountain Reservoir, 1 (RMNP); *between Shadow Mountain and Granby reservoirs,* 1 (CU); *5 mi. S, 3 1/2 mi. W Grand Lake,* 1 (UNM); *8 mi. S, 4 1/2 mi. W Grand Lake,* 6 (UNM); 9 1/2 mi. N Kremmling, 4 (2 CU, 2 FWS); Hot Sulphur Springs, 7660 ft., 11 (3 AMNH, 8 WC); near Kremmling, between Grand and Blue rivers, 1 (WC); 7 mi. below Hot Sulphur Springs, 2 (WC); Coulter, 1 (USNM); near Sheephorn Pass, 2 (WC); *Middle Park,* 3 (CU); *no locality other than county,* 1 (CSU). SUMMIT COUNTY: Dillon, 1 (UNM); junction U.S. Highway 6 and Colorado Highway 91, 9850 ft., 4 (3 CSU, 1 CU). BOULDER COUNTY: 3 1/2 mi. N, 2 mi. E Ward, 5 (WC); 6 mi. W Boulder, Magnolia Road, 1 (KU). CLEAR CREEK COUNTY: Graymount, 9700 ft., 1 (SC). PITKIN COUNTY: Sopris [White River] National Forest, W of Thomasville, 1 (USNM); Aspen, 1 (FMNH). LAKE COUNTY: 10 mi. S Leadville, 1 (UMMZ); *12 mi. S Leadville,* 1 (UMMZ). PARK COUNTY: 6 mi. NNW Grant, 9200 ft., 2 (FWS); 2 mi. N Alma, 7 (DMNH); *4 mi. W Alma, 12,000 ft.,* 2 (UI); Alma, 1 (CSU); *Sacramento Flat, between Alma and Fairplay,* 1 (USNM); Fairplay, 3 (2 SC, 1 UMMZ); *Western [Weston?] Ranch, near Fairplay,* 1 (USNM); 12 mi. S, 7 mi. W Fairplay, 4 (UNM); Trout Creek, Garo, 1 (USNM); *no locality other than county,* 2 (DMNH). GUNNISON COUNTY: Taylor Reservoir, 1 (CU). CHAFFEE COUNTY: 8 mi. NE Buena Vista, 2 (CU); 6 mi. E Buena Vista, 8000 ft., 2 (FWS); Chubb's Park, 1 (CSU). FREMONT COUNTY: *12 1/2 mi. NE Salida,* 1 (CSU). County unknown: *Soda Springs,* 2 (DMNH); Fish Creek, 3 (USNM).

Additional records (Hansen, 1962b:62, unless otherwise noted): MOFFAT COUNTY: *about 10 mi. W Lay* (Warren, 1910b:156); Axial (Felger, 1910:143). ROUTT COUNTY: 10 mi. NW Hahn's Peak (Cary, 1911:90). LARIMER COUNTY: Cherokee Park (Nadler, 1968:80); *Prairie Divide, 6 1/2 km. N Red Feather Lakes* (Hansen and Reed, 1969: 290); 1 mi. N Waverly (Burnett, 1931:22). WELD COUNTY: T. 11, 12 N, R. 65-67 W (Burnett, *loc. cit.*). RIO BLANCO COUNTY: Rangely. GARFIELD COUNTY: Rifle Gap (Felger, 1910:143). EAGLE COUNTY: *Wolcott* (Warren, 1906:242); Minturn (Warren, 1910b:156). GRAND COUNTY: *Fraser* (Warren, 1912a:4). SUMMIT COUNTY: (Warren, 1910b:156). GILPIN COUNTY: Rollinsville; Central City. CLEAR CREEK COUNTY: *Empire, 8290 ft.* (Warren, 1912a:4). JEFFERSON COUNTY: T. 4 S, R. 71 W; 2 mi. E Estabrook. PITKIN COUNTY: *above Norrie, 8454 ft.* (Warren, 1942:124). LAKE COUNTY (Burnett, 1923:12): Malta; near Koco. PARK COUNTY: 200 ft. N Shawnee P. O.; Kenosha Pass; *1/2 mi. S Jefferson; Tarryall Creek, 9 4/10 mi. SE Jefferson;* 1/2 mi. E dam, Tarryall Reservoir; 1 mi. N Tarryall; 2 mi. E Hartsel; *Mount Lincoln* (Blake and Blake, 1969:36); *1 8/10 mi. S Fairplay; South Platte River, 12 1/10 mi. S Fairplay; Buffalo Creek, 19 3/10 mi. S Fairplay;* Trout Creek Pass; Badger Creek, 3 mi. S Bassam Guard Station; Badger Creek, 5 mi. S, 7 mi. E Bassam Guard Station; 6 mi. S, 7 mi. W Bassam Guard Station. GUNNISON COUNTY: *1/2 mi. E Taylor Reservoir.* CHAFFEE COUNTY: *5 mi. SSW Trout Creek Pass; 7 mi. SSW Trout Creek Pass;* 11 mi. S Trout Creek Pass; *16 2/10 mi. S Trout Creek Pass.* FREMONT COUNTY: *21 mi. N Cotopaxi;* 12 mi. NE Salida; 15 mi. ENE Salida; Colorado State Prison Farm, near Cañon City.

Spermophilus tridecemlineatus

Thirteen-lined Ground Squirrel

The thirteen-lined ground squirrel ranges widely in Colorado. Typically a mammal of the Great Plains, populations have followed grassland communities to considerable elevations, about 9000 feet in the Upper Arkansas Valley and South Park. Preferred habitat is low bunchgrasses on friable sandy loams. Burrows are not marked by a mound of excavated earth, but frequently are at the base of low shrubs or acaulescent vegetation. In the gently rolling country of eastern Colorado, burrows are almost invariably built with a southern to eastern exposure, and on slopes or ridgetops rather than in depressions.

Although a common mammal over the grasslands of Colorado, *Spermophilus tridecemlineatus* cannot be said to be generally distributed. Populations are local and distribution is apparently strongly influenced by soil characteristics. A correlate of the pattern of localized distribution is a pattern of microgeographic variation, particularly in color of pelage. Notes on such variation in peripheral populations were published elsewhere (Armstrong, 1971b).

For a discussion of the natural history of *S. tridecemlineatus,* see V. Bailey (1893). Maxell and Brown (1968) studied habitat preferences of the species in eastern Wyoming.

Spermophilus tridecemlineatus arenicola (A. H. Howell)

Citellus tridecemlineatus arenicola A. H. Howell, Proc. Biol. Soc. Washington, 41:213, 18 December 1928; type locality, Pendennis, Lane Co., Kansas.

Spermophilus tridecemlineatus arenicola, Hall, Misc. Publ., Univ. Kansas Mus. Nat. Hist., 7:92, 13 December 1955.

Distribution in Colorado. — Southeastern part of state (Fig. 46).

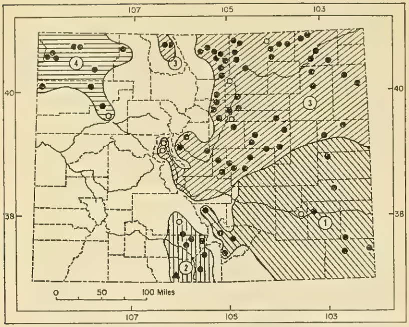


FIG. 46. Distribution of *Spermophilus tridecemlineatus* in Colorado. 1. *S. t. arenicola.* 2. *S. t. blanca.* 3. *S. t. pallidus.* 4. *S. t. parvus.* For explanation of symbols, see p. 9.

Comparisons.—From *S. t. pallidus,* geographically adjacent to the north, *S. t. arenicola* differs in generally smaller external size, slightly smaller average cranial size, and paler (more reddish) color of dorsal stripes (after A. H. Howell, 1938:111). For comparison with *S. t. blanca,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of 12 males, followed by those of four females, all from Baca County, are: 234.5 (216-251), 238.3 (225-253); 74.3 (61-82), 74.0 (70-82); 32.9 (30-35), 33.4 (32-35). Two males and a female weighed 121.7, 129.0, and 105.3, respectively. For cranial measurements, see table 11.

Remarks.—Specimens from montane valleys of Custer and Huerfano counties are markedly smaller in external and cranial size than specimens of *arenicola* from the plains of southeastern Colorado. In addition, individuals from the Wet Mountain Valley are much darker in color than is usual in *arenicola.* The incidence of such a pattern of variation in semi-isolated peripheral populations of *S. tridecemlineatus* is frequent in montane areas of Colorado and adjacent states (see Armstrong, 1971b). Specimens from Westcliffe were referred by A. H. Howell (1938:119) to the subspecies *S. t. parvus,* the geographic race of the Wyoming and Uinta basins.

Records of occurrence.—Specimens examined, 30, distributed as follows: CHEYENNE COUNTY: Eureka Hill, 4850 ft., 1 (USNM). CUSTER COUNTY: 4 mi. W Westcliffe, 1 (CU); *Westcliffe, 7800 ft.,* 2 (WC). KIOWA COUNTY: Eads, 1 (DMNH); *no locality other than county,* 1 (DMNH). HUERFANO COUNTY: 3 mi. N Muddy Creek, 1 (WC); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 1 (KU); La Veta, 7012 ft., 1 (KU). BENT COUNTY: Las Animas, 1 (USNM). PROWERS COUNTY: 1 mi. N Two Buttes Reservoir, 4350 ft., 1 (KU); 15 1/2 mi. N, 4 mi. E Springfield, 2 (KU); 15 mi. N, 4 mi. E Springfield, 1 (KU). BACA COUNTY: Monon, 7 (1 AMNH, 6 WC); N of Springfield, 5 (WC); Springfield, 2 (1 AMNH, 1 MCZ); S of Springfield, 1 (WC).

Additional records: CUSTER COUNTY: *on Swift Creek* (Cockerell, 1890:7). OTERO COUNTY: "Bent's Fort, N.M." (Baird, 1858:218).

Spermophilus tridecemlineatus blanca Armstrong

Spermophilus tridecemlineatus blanca Armstrong, Jour. Mamm., 52:533, 26 August 1971.

Distribution in Colorado.—San Luis Valley (Fig. 46).

Comparisons.—From both *S. t. arenicola* and *S. t. pallidus,* the subspecies *S. t. blanca* differs in smaller external and cranial size, larger auditory bullae, and paler color, the ground color of the dorsum being more heavily admixed with pale hairs, and the markings being white rather than buffy.

Measurements.—External measurements of two males, followed by mean (and extremes) of eight females, all from Alamosa, Conejos, and Costilla counties, are: 232, 231, 218.5 (210-230); 84, 88, 78.8 (74-88); 31, 31, 30.5 (28-33); 9, 9, —. Selected cranial measurements are presented in table 11.

Remarks.—The population of *S. tridecemlineatus* of the San Luis Valley was for many years referred to *S. t. parvus,* the subspecies of the Wyoming Basin. Thirteen-lined ground squirrels do not occur in west-central and southwestern Colorado, however, and the former concept of *parvus* was grossly polytopic. Although differing in detail, the subspecies *blanca* and *parvus* do show close phenetic similarities, although there seems to me no reason to suppose that the two kinds have any close genetic relationship. Both subspecies occur in areas of semidesert shrublands on pale, alkaline soils. The similarity of the two kinds obviously is a convergent response to closely comparable environmental pressures. Phenotypic convergence of this nature is seen also in the least chipmunk, between the subspecies *Eutamias minimus minimus* of the Wyoming Basin and *E. m. caryi* of the San Luis Valley.

For further comments on the nomenclatural history of thirteen-lined ground squirrels of the San Luis Valley, see Armstrong (1971b).

Records of occurrence.—Specimens examined, 33, distributed as follows: SAGUACHE COUNTY: 9 mi. E Center, 6 (AMNH). ALAMOSA COUNTY: San Luis Lakes, 7680 ft., 1 (WC); *Medano Ranch, 15 mi. NE Mosca, 7700 ft.*, 3 (WC); Mosca, 7562 ft., 1 (WC); 3 mi. S Great Sand Dunes National Monument, 4 (MVZ); *San Luis Valley, 7600 ft.*, 2 (AMNH). CONEJOS COUNTY: Conejos River, 5 mi. W Antonito, 1 (MVZ); *Antonito*, 2 (USNM). COSTILLA COUNTY: Fort Garland, 4 (USNM); *San Acacio, 7737 ft.*, 3 (WC); 2 mi. S San Acacio, 2 (CSU); *no locality other than county*, 4 (CSU).

Additional records: SAGUACHE COUNTY: Moffat (Warren, 1910b:162). CONEJOS COUNTY: La Jara (Cary, 1911:93). COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:281).

Spermophilus tridecemlineatus pallidus J. A. Allen

[Spermophilus tridecemlineatus] var. *pallidus* J. A. Allen, Proc. Boston Soc. Nat. Hist., 16:291, 4 February 1874 *(nomen nudum)*.

[Spermophilus tridecemlineatus] var. *pallidus* J. A. Allen, *in* Coues and Allen, Monographs of North American Rodentia, p. 872, August 1877; type locality, "plains of lower Yellowstone River," Montana (see remarks beyond).

Distribution in Colorado. — Northeastern and east-central parts of state (Fig. 46).

Comparisons.—For comparison with *S. t. arenicola* and *S. t. blanca*, see accounts of those subspecies. From *S. t. parvus*, the subspecies of the Wyoming and Uinta basins, *S. t. pallidus* differs in larger external and cranial size and darker color, the pale dorsal stripes being buffy rather than nearly white.

Measurements.—Mean (and extreme) external measurements of eight males, followed by those of five females, all from eastern Larimer County, are: 244.6 (212-260), 248.6 (228-260); 84.2 (78-104), 89.2 (76-98); 32.4 (30-35), 33.2 (31-35); 8.0 (6-11), —; mean weight of five of the above males, 158.30 (125.0-193.5), weights of three females, 145.2, 136.0, 128.0. Mean (and extreme) total lengths and lengths of tail for eight males and 14 females from Adams and Denver counties are: 235.0 (227-263), 245.7 (236-253); 86.3 (77-95), 84.1 (65-100); those for four males and four females from Weld County are: 228.0 (208-238), 238.0 (215-250); 75.8 (66-85), 83.0 (78-89). Selected cranial measurements are presented in table 11.

Remarks.—A. H. Howell (1938:112) selected a lectotype (USNM 16237) and fixed the type locality of *pallidus* as "mouth of the Yellowstone River, Mont." The mouth of the Yellowstone is not in Montana, but in McKenzie County, North Dakota. The type locality as thus restricted is at the northern edge of the range of the subspecies, and specimens from near the mouth of the Yellowstone are, in fact, intergrades between *pallidus* and *tridecemlineatus* (Jones, 1964:133).

Cockrum (1952:124) referred all thirteen-lined ground squirrels from western Kansas to *S. t. arenicola* without comment. Jones (1964: 133) referred specimens from the western two-thirds of Nebraska to *S. t. pallidus*, remarking on the difficulty of subspecific distinction in populations of *S. tridecemlineatus* on the plains. The principal criteria for distinguishing *arenicola* from *pallidus* are the slightly paler color and smaller size of the former subspecies. The color of specimens varies individually with mechanical abrasion and bleaching, with ontogenic stage, and perhaps also genetically. Individuals in comparable pelage from the same locality may range in color from grayish buff, with the usually dark dorsal stripes obscure, to nearly the rich brown characteristic of the species in the true prairie to the east (nominotypical *tridecemlineatus*). In Colorado, the most variable populations are those in the northeastern and east-central parts of the state; in the southeast, individual variation seems to be less and the populations generally have the pale color and small size of *arenicola*. According to Jones (1964:133), "the differences between *arenicola* and *pallidus* are slight and clinal in nature; the area of intergradation between the two is broad. . . . Possibly the recognition of two subspecies on the Great Plains . . . is unwarranted." Some variation apparently is microgeographic. Specimens from localities with especially sandy soils (Sterling, Wray, Greeley) may have the pale color of *arenicola* although surrounded by local populations clearly referable to *pallidus*. With additional collecting and careful analysis of variation both within and between populations, it might be possible to describe geographic variation in *S. tridecemlineatus* on the plains; currently recognized subspecies in eastern Colorado do not describe existing variation adequately. For the purposes of the present checklist, however, recognition of two eastern subspecies is tentatively maintained. Specimens from south of the Arkansas River are referable to *arenicola*, the subspecies of the southern Great Plains, on the basis of size; specimens from north of the South Platte River are generally referable to *pallidus*, although some specimens from along the South Platte (for example, USNM 35086-90, from Sterling) agree in most characters with *arenicola*, to which subspecies they were referred by Howell (1938:112). In several instances, specimens from the broad interfluve between the Arkansas and South Platte might be referred equally well to either named kind as currently understood. No really adequate series of specimens is available from this part of the state.

The boundary between the two subspecies in eastern Colorado is drawn generally along the Platte-Arkansas Divide: the boundary is accorded little zoogeographic significance. Specimens from El Paso County, although mostly from the Arkansas drainage, agree more closely with *pallidus*, to which subspecies they are referred. Specimens from Teller County are smaller than typical *pallidus* from the plains to the east and are dark in color. Among other Coloradan material examined, specimens from Divide and near Gillett most closely resemble those from Westcliffe, Custer County, herein referred to *arenicola*. The spatial relationships of the above-mentioned highland populations to the conterminous ranges of their respective subspecies are similar (see Armstrong, 1971b).

A specimen from near Berthoud (CU 1172, a female) is an albino.

Records of occurrence.—Specimens examined, 219, distributed as follows: JACKSON COUNTY: Canadian Creek, 4 (USNM); 5 mi. E Canadian Creek, 1 (USNM). LARIMER COUNTY: Livermore, 2 (KU); Elkhorn, 7000 ft., 1 (USNM); 12 mi. NW Fort Collins, 1 (CU); 1 mi. SE Bellvue, 1 (CU); *2 mi. W Fort Collins, 5200 ft.,* 1 (CSU); *1 1/2 mi. W Fort Collins,* 1 (CSU); *W of Fort Collins,* 1 (CSU); *Fort Collins,* 4 (3 CSU, 1 CU); *1 mi. S, 3 1/2 mi. W Fort Collins, 5040 ft.,* 1 (CSU); *3 1/2 mi. SE Fort Collins,* 1 (CSU); *3 mi. S Fort Collins,* 1 (CSU); *3 1/4 mi. SW Fort Collins, 5200 ft.,* 1 (CSU); *1 mi. NE Spring Canyon Dam,* 1 (CU); Spring Canyon, 2 (1 CSU, 1 CU); 5 1/2 mi. S, 1 1/2 mi. E Fort Collins, 1 (CU); *5 6/10 mi. S, 2 3/10 mi. E Fort Collins, 5200 ft.,* 1 (CSU); *2 1/2 mi. WNW Loveland,* 1 (CSU); Loveland, 24 (USNM); near Berthoud, 1 (CU); *no locality other than county,* 14 (CSU). WELD COUNTY: Rockport, 1 (DMNH); 9 mi. N, 3 mi. E Nunn, 5 (UNM); Pawnee Buttes, 5700 ft., 1 (WC); 8 mi. NE Pawnee Buttes, 1 (USNM); *Horsetail Creek, 17 mi. NW Stoneham,* 6 (DMNH); 12 mi. NW New Raymer, 1 (CU); Central Plains Experiment Station, Nunn, 2 (1 CSU, 1 CU); 2 1/2 mi. N, 12 1/2 mi. E Fort Collins, 2 (1 CSU, 1 CU); 1 8/10 mi. S Buckingham, 2 (1 CSU, 1 CU); *2 mi. N, 2 mi. W Greeley,* 1 (CSC); Greeley, 2 (1 CSC, 1 USNM). LOGAN COUNTY: 5 mi. W Peetz, 2 (KU); 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU); 9 mi. NE Sterling, 1 (KU); Sterling, 6 (1 DMNH, 5 USNM); Leroy, 1 (USNM). BOULDER COUNTY: *Valmont,* 1 (USNM); Boulder, 5 (3 ANSP, 1 CU, 1 USNM); *2 mi. E Boulder,* 1 (CU); *Kane Lake,* 1 (CU). JEFFERSON COUNTY: Rocky Flats, 1 (CU); Golden, 2 (USNM); Morrison, 1 (SC). ADAMS COUNTY: Barr, 3 (DMNH); *E of Denver,* 1 (CU); 10 mi. E Denver, 1 (CU); *no locality other than county,* 1 (DMNH). DENVER COUNTY: Denver, 34 (11 AMNH, 5 CU, 16 DMNH, 1 KU, 1 USNM); *Alcott,* 1 (CU). ARAPAHOE COUNTY: Deer Trail, 1 (DMNH). WASHINGTON COUNTY: 13 mi. S Sterling, 1 (KU); *Eastern Colorado Range Experiment Station, 15 mi. N Akron,* 2 (CSU); Akron, 1 (UMMZ). YUMA COUNTY: 20 mi. NW Wray, 1 (KU); Wray, 3 (DMNH). PARK COUNTY: *Tarryall Creek, 9000 ft.,* 1 (WC); *3 mi. SW Tarryall River,* 1 (CU); Como, 9800 ft., 5 (USNM); Fairplay, 1 (MCZ); Puma City, 8500 ft., 1 (WC); *Cartrel's Park* (not found), 1 (MCZ); *no locality other than county,* 2 (MCZ). DOUGLAS COUNTY: 2 mi. SW Parker, 1 (DMNH); *3 mi. SE Parker,* 1 (CU). ELBERT COUNTY: 6 mi. N Riverbend, 1 (CU); Kiowa, 1 (CU); 6 mi. S Elbert, 1 (UMMZ); 12 mi. E Simla, 1 (UMMZ); *between Matheson and Resolis,* 1 (WC). KIT CARSON COUNTY: Tuttle, 1 (USNM); 4 mi. E Flagler, 7 (KU); *no locality other than county,* 1 (UMMZ). TELLER COUNTY: Divide, 9200 ft., 7 (1 AMNH, 1 CSU, 1 MCZ, 4 WC); 1 mi. N Gillet, 5 (UNM). EL PASO COUNTY: 2 mi. W Ramah, 5000 ft., 2 (KU); 5 mi. SE Peyton, 1 (UMMZ); *7 mi. SE Peyton,* 1 (UMMZ); *9 mi. SE Peyton,* 1 (UMMZ); Manitou, 1 (UMMZ); *2 mi. NE Colorado Springs,* 4 (WC); *N of Colorado Springs,* 1 (WC); *near Colorado Springs, 6000 ft.,* 1 (WC); *Colorado Springs,* 12 (4 AMNH, 3 MCZ, 5 WC); 15 mi. E Colorado Springs, 2 (UMMZ).

Additional records: LARIMER COUNTY: *Trilby*

(Markham, 1907:145). WELD COUNTY: Grover (Markham, 1907:145); St. Vrain River, 1 mi. S, 6 mi. W Platteville (Archibold, 1964:44). ARAPAHOE COUNTY: 5 mi W Englewood (Nadler and Hughes, 1966:47). LAKE COUNTY: [near] head of Arkansas River (Baird, 1858:317); Twin Lakes (Coues and Yarrow, 1875:120). PARK COUNTY: *South Park* (J. A. Allen, 1874:57). KIT CARSON COUNTY: *Beloit* (not found) (V. Bailey, 1893:34).

Spermophilus tridecemlineatus parvus
J. A. Allen

Spermophilus tridecemlineatus parvus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:337, 8 November 1895; type locality, Kennedy's Hole, 20 mi. NE Ouray, Uintah Co., Utah.

Distribution in Colorado.—Northwestern part of state, generally north of Roan Plateau (Fig. 46).

Comparison.—For comparison with *S. t. pallidus,* see account of that subspecies.

Measurements.—External measurements of two males and three females from Moffat County are, respectively: 205, 214, 228, 210, 189; 87, 75, 85, 75, 65; 30, 31, 30, 28, 28. Cranial measurements are given in table 11.

Remarks.—*Spermophilus t. parvus* is the smallest of recognized geographic races of *S. tridecemlineatus.* A. H. Howell (1938:118) provisionally referred specimens from the San Luis Valley in Colorado to *parvus.* Following that arrangement, Hall and Kelson (1959:346) mapped the range of *parvus* as extending through most of western Colorado. In fact, the thirteen-lined ground squirrel is not known certainly south of the White River Plateau. Cary (1911:93) noted that "nothing is known of the distribution of *parvus* in the region between the White River Plateau and the San Luis Valley aside from a specimen in the U. S. National Museum labeled 'Elk Mts.,' collected by Capt. Stevenson September 6, 1873." That specimen (USNM 15050) was not listed by Howell (*op. cit.*) as examined. However, he did know of the specimen and had identified it as nominotypical *tridecemlineatus,* probably because of its dark color. I doubt that the specimen is from the Elk Mountains of current usage, the range along the Pitkin-Gunnison county line. It seems to me more likely that the specimen is from the Elkhead Mountains or the Elk River drainage, Routt County. The isolated population of thirteen-lined ground squirrels of the San Luis Valley now is recognized as a distinct subspecies. Resemblance of that population to *S. t. parvus* apparently is a matter of convergence in the face of closely comparable environmental pressures.

A specimen (CSU, uncatalogued, a female) labelled "Routt County" is an albino.

Records of occurrence.—Specimens examined, 26, distributed as follows: MOFFAT COUNTY: [Little] Snake River, 4 (DMNH); 5 mi. W [Little] Snake River, 1 (WC); 6 mi. NW Greystone, 1 (CU); N base Escalante Hills, 6500 ft., 1 (USNM); Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 1 (DMNH); 12 mi. SE Lay, 2 (USNM); *no locality other than county,* 4 (CSU). ROUTT COUNTY: "Elk Mts." (see remarks, above), 1 (USNM); *no locality other than county,* 1 (CSU). RIO BLANCO COUNTY: 5 mi. W Rangely, 5600 ft., 1 (USNM); *2 mi. W Rangely,* 1 (USNM); between Axial and Meeker, 1 (WC); *Compass Creek, 9000 ft.* (not found), 2 (AMNH). GARFIELD COUNTY: Mud Springs, 8850 ft., 4 (WC); *Mud Springs, 30 mi. SE Meeker, 9000 ft.,* 1 (USNM).

Additional records: GARFIELD COUNTY: West Fork Elk Creek, 6 to 8 mi. above New Castle (Warren, 1910b:162).

Spermophilus spilosoma
Spotted Ground Squirrel

The spotted ground squirrel inhabits areas of sandy soil on the Great Plains in eastern Colorado and in the extreme southwestern corner of the state. Little has been reported regarding the habits of this species, and it apparently has never been abundant in Colorado. Certainly it is not so conspicuous today on the plains as is the thirteen-lined ground squirrel. However, Cary (1911:93) noted that in 1909 residents east of Wray reported *Spermophilus spilosoma* as more abundant than *Spermophilus tridecemlineatus.* Abandoned burrow systems of other rodents, particularly kangaroo rats, are used extensively. Soils of a texture suitable for *Dipodomys ordii* generally are suitable for *S. spilosoma* also, but the range of the spotted ground squirrel in Colorado is not as extensive as that of the kangaroo rat.

For ecological notes on *S. spilosoma* in southeastern Wyoming, see Maxell and Brown (1968). V. Bailey (1893) and Burnett (1924b) presented observations on the natural history and economic importance of Coloradan ground squirrels.

Spermophilus spilosoma cryptospilotus Merriam

Spermophilus cryptospilotus Merriam, N. Amer. Fauna, 3:57, 11 September 1890; type locality, "Tenebito" [Dinnebito] Wash, Painted Desert, Coconino Co., Arizona.

Spermophilus spilosoma cryptospilotus, Hall and Kelson, The mammals of North America, p. 349, 31 March 1959.

Distribution in Colorado. — Known only from western Montezuma County (Fig. 45).

Comparisons.—From *S. s. marginatus* and *S. s. obsoletus*, both of which occur in eastern Colorado, *S. s. cryptospilotus* differs in smaller external and cranial size, and smaller, more numerous dorsal spots.

Measurements.—External measurements of a male and female from Ackmen, Montezuma County, are: 219, 224; 60, 64; 33, 32. Selected cranial measurements are presented in table 11.

Remarks.—McCampbell (1926) noted that specimens captured by him (in sec. 35, T. 35 S, R. 16 W, S of Cortez) were taken in abandoned burrows of prairie dogs (*Cynomys gunnisoni zuniensis*), and that the two specimens obtained were the only individuals observed during a summer of field work at that locality.

Records of occurrence.—Specimens examined, 4, distributed as follows: MONTEZUMA COUNTY: Ackmen, 2 (FMNH); S of Cortez, 6200 ft., 1 (CSU); *no locality other than "Montezuma,"* 1 (CSU).

Spermophilus spilosoma marginatus V. Bailey

Spermophilus spilosoma major Merriam, N. Amer. Fauna, 4:39, 8 October 1890; type locality, Albuquerque, Bernalillo Co., New Mexico. Not *Mus citellus* var. *major* Pallas, 1779.

Spermophilus spilosoma marginatus V. Bailey, Proc. Biol. Soc. Washington, 15:118, 2 June 1902; type locality, Alpine, Brewster Co., Texas.

Distribution in Colorado.—In suitable habitat in southeastern and east-central parts of state (Fig. 45).

Comparisons.—For comparison with *S. s. cryptospilotus* and *S. s. obsoletus*, see accounts of those subspecies.

Measurements.—External measurements of two males and three females from Las Animas, Bent County, are, respectively: 234, 241, 251, 260, 242; 80, 73, 79, 84, 74; 35, 36, 35, 35, 32. External measurements of two males from northern Baca County are: 248, 238; 66, 87; 35, 36. For cranial measurements, see table 11.

Records of occurrence.—Specimens examined, 26, distributed as follows: ELBERT COUNTY: halfway between Matheson and Resolis, 1 (WC); *no locality other than county*, 1 (CSU). LINCOLN COUNTY: Hugo, 1 (USNM). CHEYENNE COUNTY: Kit Carson, 4284 ft., 1 (DMNH); 10 mi. S Firstview, 3 (CU). CROWLEY COUNTY: sec. 23, T. 19 S, R. 59 W, 1 (KU). OTERO COUNTY: 1/2 mi. S, 1/4 mi. W Manzanola, 4300 ft., 1 (CSU); JJ Ranch, S side Purgatoire River, 18 mi. S La Junta, 2 (USNM). BENT COUNTY: Las Animas, 8 (USNM). PROWERS COUNTY: *2 mi. W Lamar*, 1 (WC); Lamar, 1 (CU); *SE of Lamar*, 1 (DMNH); *1 1/2 mi. S Lamar*, 1 (WC). BACA COUNTY: Monon, 1 (WC); Carrizo Creek, 1 (DMNH); Regnier, 1 (DMNH).

Additional records. ELBERT COUNTY: between Simla and Matheson (Warren, 1912a:5). CHEYENNE COUNTY: "a few miles northwest of [Cheyenne Wells]" (Cary, 1911:93). PUEBLO COUNTY: Pueblo (Warren, 1906:242).

Spermophilus spilosoma obsoletus Kennicott

Spermophilus obsoletus Kennicott, Proc. Acad. Nat. Sci. Philadelphia, 15:157, 1863; type locality, 50 mi. W Fort Kearney [vicinity of Gothenburg, Dawson Co.], Nebraska (see A. H. Howell, 1938:131 and Jones, 1964:129).

Spermophilus spilosoma obsoletus, Hall, Misc. Publ., Univ. Kansas Mus. Nat. Hist., 7:94, 13 December 1955.

Distribution in Colorado. — Drainage of South Platte River, northeastern part of state (Fig. 45).

Comparisons.—From *S. s. marginatus*, the subspecies of southeastern Colorado, *S. s. obsoletus* differs in smaller average external size, and generally more grayish (less cinnamon) dorsal color; the dorsal spots of *obsoletus* tend to be ill-defined. For comparison with *S. s. cryptospilotus*, see account of that subspecies.

Measurements. — Average (and extreme) external measurements of 11 males, followed by those of seven females, all from Weld and Adams counties, are: 232.6 (220-242), 226.8 (212-245); 64.8 (50-75), 64.8 (59-73); 34.0 (30-37), 31.8 (30-34). Representative cranial measurements are presented in table 11.

Remarks.—Spotted ground squirrels are most abundant in Colorado in the sand hills of the northeastern part of the state and along the Arkansas River in the southeast. In the intervening area, suitable habitat is limited, populations are small, and available specimens are few. In part, this is an indication of a lack of concerted collecting efforts in suitable localities, but also it reflects the scarcity of the species.

Despite large average cranial size, samples from northeastern Colorado are clearly referable to S. *s. obsoletus,* the subspecies of the Sand Hills of Nebraska, on the basis of external features. Specimens from the Arkansas River Valley resemble S. *s. marginatus* of the Southern Great Plains in their relatively bright pelage, suffused with cinnamon, and prominent, typically distinct dorsal spots. The available specimens from interfluvial localities generally are equivocal. According to A. H. Howell (1938:127), *marginatus* "passes insensibly into subspecies . . . *obsoletus;* most of the specimens from eastern Colorado, north of the Arkansas Valley, are so completely intermediate between the two forms that it is very difficult to say which form they most resemble." Howell referred apparent intergrades from Wray and Barr Lake to the southern subspecies; they are herein considered to represent *obsoletus.* Specimens from Fosston and Akron, referred by Howell to *"major"* (=*marginatus*) are referred by me to *obsoletus* on the basis of characteristics of a majority of specimens from the northeastern part of the state.

Records of occurrence.—Specimens examined, 44, distributed as follows: WELD COUNTY: Fosston, 2 (WC); *Cornish,* 1 (CU); 2 mi. E Greeley, 1 (CSC); *Latham Reservoir,* 1 (DMNH); 2 mi. S Latham Reservoir, 1 (CSC); Empire Reservoir, 2 (DMNH); 8 mi. E Roggen, 1 (CU); Hudson, 1 (CU). MORGAN COUNTY: Jackson Lake, 1 (DMNH); NW of Brush, 1 (CU); 5 mi. S Brush, 1 (UNM). LOGAN COUNTY: 10 mi. E Avalo, 1 (USNM); Sterling, 2 (USNM); 10 mi. SE Sterling, 1 (USNM). SEDGWICK COUNTY: Harris Ranch, near Julesburg, 1 (CSU). BOULDER COUNTY: White Rocks, 1 (WC). ADAMS COUNTY: *Boot Lake,* 1 (DMNH); Barr Lake, 6 (DMNH); 5 mi. N Fitzsimmons Hospital, 1 (CSC); *Mile Hi Gun Club,* 3 (DMNH); *no locality other than county,* 7 (DMNH). DENVER COUNTY: Sand Creek, 1 (CU). WASHINGTON COUNTY: *Eastern Colorado Range Experiment Station, near Akron,* 1 (CSU); Akron, 1 (UMMZ). YUMA COUNTY: Wray, 1 (DMNH); *3 mi. S Wray,* 1 (USNM); Dry Willow Creek, 1 (CU). KIT CARSON COUNTY: Tuttle, 1 (USNM).

Additional records: LOGAN COUNTY: Merino (A. H. Howell, 1938:131). KIT CARSON COUNTY: *5 mi. E Tuttle* (Cary, 1911:93).

Spermophilus variegatus

Rock Squirrel

The rock squirrel occurs throughout the southwestern United States and northern Mexico. *Spermophilus variegatus* is found most commonly in areas of broken rock, and is the largest member of the genus in Colorado. On the Eastern Slope, rock squirrels are not uncommon in canyons and in quarries in the sedimentary formations that flank the Front Range, north to the Cache la Poudre drainage, but apparently stopping short of the Wyoming boundary. *Spermophilus variegatus* occupies the Arkansas River Valley at least as high as Buena Vista (8200 feet), and occurs on slopes of mesas and cuestas in southeastern Colorado and in the western part of the state, north to the Roan Plateau. The northernmost record on the Western Slope is from a place 31 mi. SW of Meeker, probably on Parachute Creek. I have seen no specimens that definitely are from the White River drainage. Seemingly the rock squirrel is more abundant in southern Colorado than at the northern extremes of its range.

Wade and Gilbert (1940) described the baculum of the rock squirrel. Gerber and Birney (1968) reported immunological studies of *S. variegatus* from Colorado.

Spermophilus variegatus grammurus (Say)

S[ciurus]. grammurus Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 2:72 (footnotes), 1823; type locality, Purgatoire River, near mouth of Chacuacho Creek, Las Animas Co., Colorado.

Spermophilus variegatus grammurus, Hall and Kelson, Univ. Kansas Publ., Mus. Nat. Hist., 5:346, 15 December 1952.

Distribution in Colorado.—Foothills of Eastern Slope north to vicinity of Fort Collins; mesas of Raton Section; western canyons and plateaus north to Roan Plateau (Fig. 47).

Measurements.—External measurements of three males and three females from Montrose and Montezuma counties are, respectively: 498, 484, 485, 461, 443, 470; 237, 200, 204, 211, 183, 197; 56, 61, 60, 61, 61, 61. Mean (and extreme) external measurements of five females from Las Animas and Baca counties are: 470.0 (440-498), 197.2 (176-223), 59.2 (58-60), 30.0 (29-31). Cranial measurements are presented in table 11.

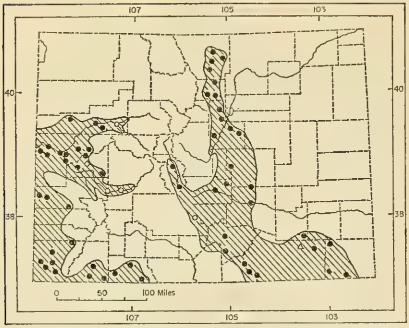


FIG. 47. Distribution of *Spermophilus variegatus grammurus* in Colorado. For explanation of symbols, see p. 9.

Remarks.—Warren (1906, 1908b, 1910b) referred rock squirrels from several localities in western Colorado to the subspecies *S. v. utah.* Howell (1938:145) assigned all Colorado-taken specimens to *S. v. grammurus,* as had been suggested by Cary (1911:87). Warren later (1942:118) concurred with that treatment. All material from Colorado examined by me falls within the range of variation seen in specimens of *grammurus* from Las Animas County. If *S. variegatus* should be found to occur along the Green River in western Moffat County, *S. v. utah* is the subspecies to be expected. Durrant and Hansen (1954:268) reported that race from a locality 15 mi. S of Ouray, Uintah Co., Utah.

Records of occurrence.—Specimens examined, 198, distributed as follows: LARIMER COUNTY: 9 mi. NW Fort Collins, 1 (CU); *1/2 mi. NE Bellvue,* 1 (CU); *1/4 mi. N Watson Lake, 2 mi. N, 4 mi. W Fort Collins,* 1 (CSU); *Watson Lake, Bellvue,* 2 (1 CSU, 1 CU); *2 mi. N, 2 mi. W Fort Collins,* 2 (1 CSC, 1 CSU); *2 mi. N Fort Collins,* 1 (CU); *Fort Collins,* 1 (CU); *E of Fort Collins,* 1 (CSU); *2 mi. E Fort Collins, 4900 ft.,* 2 (CSU); 3 1/2 mi. E Fort Collins, 1 (CSU); *NE 1/4 sec. 13 T. 7 N, R. 69 W,* 2 (1 CSU, 1 CU); *2 7/10 mi. SE Fort Collins,* 2 (CSU); *3 mi. SE Fort Collins,* 2 (CSU); Horsetooth Mountain, 1 (CSU); *8 mi. up Buckhorn Canyon,* 1 (CSC); Pinewood, 1 (USNM); *no locality other than county,* 2 (USNM). GARFIELD COUNTY: 31 mi. SW Meeker, 1 (CU); Rifle, 1 (USNM); *near Rifle,* 5 (DMNH); 12 mi. SE Rifle, 4 (FMNH). BOULDER COUNTY: Lyons, 1 (USNM); Sugarloaf, 1 (CU); *1 mi. NW Boulder,* 2 (KU); *5 mi. W Boulder, 6000 ft.,* 2 (1 CU, 1 USNM); *Boulder Canyon, 6000 ft.,* 2 (CU); Boulder, 10 (1 ANSP, 3 CU, 5 FMNH, 1 USNM); *Halfway House, Flagstaff Mountain,* 1 (CU); *S of Boulder,* 2 (CU); *Skunk Canyon, 2 mi. S Boulder,* 2 (CU). JEFFERSON COUNTY: Wheatridge, 2 (1 CU, 1 DMNH); Morrison, 1 (CU); *Mount Vernon Canyon,* 1 (FWS); Dome Rock, 1 (AMNH); *Platte Canyon,* 1 (CU); *no locality other than county,* 2 (1 DMNH, 1 UI). MESA COUNTY: 1 mi. SW Fruita, 1 (DMNH); 1 mi. N Mesa, 1 (CU); *Plateau Creek, 12 mi. E Tunnel,* 1 (USNM); 4 mi. S, 4 mi. E Collbran, 6800 ft., 3 (KU); Sieber Ranch, Little Dolores Creek, 2 (WC); Grand Junction, 4 (1 CU, 2 FMNH, 1 WC); *7 mi. E Grand Junction,* 1 (CSU); 1 mi. S, 7 mi. E Grand Junction, 1 (CSU); 1/4 mi. N Highland View, Rim Rock Drive, Colorado National Monument, 1 (CNM); Whitewater, 1 (FMNH). DOUGLAS COUNTY: Sedalia, 1 (DMNH); Franktown, 1 (DMNH). DELTA COUNTY: 15 mi. NW Delta, 1 (UMMZ); Crawford, 1 (CSC). CHAFFEE COUNTY: Buena Vista, 8200 ft., 1 (USNM); *1 mi. W Salida,* 1 (CSU); Salida, 2 (WC); *Sedalia Mine, near Salida,* 1 (WC); *no locality other than county,* 2 (UMMZ). EL PASO COUNTY: *Garden of the Gods,* 1 (RMNP); *Bear Creek Canyon, near Colorado Springs,* 3 (WC); between Bear and Cheyenne creeks, near Colorado Springs, 1 (WC); *Beaver Creek, near Colorado Springs,* 1 (WC); 20 mi. N Pueblo, 1 (SCSC). MONTROSE COUNTY: West Paradox Valley, 4 (DMNH); Bedrock, 5 (2 AMNH, 3 WC); Coventry, 6800 ft., 6 (2 AMNH, 4 WC). SAN MIGUEL COUNTY: *near Coventry,* 1 (WC). FREMONT COUNTY: 15 mi. NE Cañon City, 1 (CU); Cañon City, 6 (USNM); *Glendale* (not found), 1 (WC); *no locality other than county,* 1 (FMNH). PUEBLO COUNTY: *Fountain River near new campus, Southern Colorado State College,* 1 (SCSC); NE of City Park, Pueblo, 4700 ft., 1 (SCSC); *Pueblo,* 1 (SCSC). HUERFANO COUNTY: 1 mi. ESE Farisita, 6700 ft., 1 (KU); La Veta, 2 (UMMZ). OTERO COUNTY: JJ Ranch, 18 mi. S La Junta, 3 (USNM). MONTEZUMA COUNTY: 2 mi. N, 2 mi. W Stoner, 7600 ft., 1 (KU); 1 1/2 mi. W Dolores, 7000 ft., 1 (KU); *head of McElmo Canyon,* 1 (DMNH); Ashbaugh's Ranch [Moqui], 5200 ft., 7 (2 AMNH, 1 CSU, 1 USNM, 3 WC); Cortez, 1 (WC); Ute Peak, 3 (DMNH); Spruce Tree House, Mesa Verde, 1 (DMNH). LA PLATA COUNTY: Florida, 6 (5 AMNH, 1 FMNH); Bondad, 2 (1 AMNH, 1 DMNH); Allison, 1 (UNM); *East Animas* (not found), 1 (WSC). ARCHULETA COUNTY: Pagosa Springs: 1 (DMNH); Deep Cañon, 1 (UNM); Chromo, 7 (DMNH). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 2 (WC); Ludlow, 1 (CU); Trinidad, 6 (USNM); *2 mi. S, 8 mi. E Trinidad,* 1 (KU); *Jimmie Creek,* 2 (DMNH); 3 mi. S, 8 mi. E Trinidad, 1 (KU); *no locality other than county,* 3 (DMNH). BACA COUNTY: Gaume's Ranch, 2 (WC); *Cottonwood Creek,* 3 (KU); Furnace [Furnish] Canyon, 2 (DMNH); Regnier, 3 (1 AMNH, 2 DMNH); *no locality other than county,* 7 (DMNH). County unknown: *Soda Springs,* 5 (2 MCZ, 3 USNM).

Additional records: GARFIELD COUNTY: above Glenwood Springs (Warren, 1942:118). JEFFERSON COUNTY: *"near Golden City"* (J. A. Allen, *in* Coues and Allen, 1877:836). MESA COUNTY: *Colorado National Monument* (P. H. Miller, 1964:48). DELTA COUNTY (Warren, 1942:119): Cedaredge; *Cory.* GUNNISON COUNTY (Durrant and Robinson, 1962:246): Dry Creek, 3/4 mi. N Gunnison River, 7460 ft.; *Gunnison River, 3 mi. NE Cimarron, 6907 ft.; Black Canyon of the Gunnison River, 2 mi. NE Cimarron, 7150 ft.* SAGUACHE COUNTY: Crestone (Warren, 1942:118). MONTEZUMA COUNTY (Anderson, 1961:46): *head of Prater Canyon, Mesa Verde National Park; Chickaree Draw; Headquarters Area; Ruins Road, 1/2 mi. NE Cliff Palace.* LA PLATA COUNTY (Durrant and Dean, 1961:167): 8 mi. S Ignacio; *4 mi. above mouth of Piedra River.* ARCHULETA COUNTY: *1 mi. SE Allison* (Durrant and Dean, 1961:167). LAS ANIMAS COUNTY: Purgatoire River, near junction with Chacuacho Creek (Say, *in* James, 1823, 2:72).

Spermophilus lateralis

Golden-mantled Ground Squirrel

The golden-mantled ground squirrel is an abundant and conspicuous mammal throughout much of central and western Colorado. These squirrels burrow beneath rocks, roots of trees, or buildings. Relatively open woodlands and forest edge communities are preferred habitat and the animals rarely are seen beneath the well-developed canopy of the dense forest. Range of elevation of specimens examined is approximately 5200 to 12,500 feet. Hatt (1927) noted a range of 6500 to 13,000 feet on Pikes Peak.

Hatt (*op. cit.*) presented notes on natural history of *Spermophilus lateralis* in the Front and Rampart ranges, and Carleton (1966) reported on food habits at Gothic. Gordon (1936, 1938, 1943) made behavioral observations on golden-mantled ground squirrels in the Cache la Poudre drainage. Chromosomes of *S. lateralis* were described by Nadler (1966), and Gerber and Birney (1968) used Coloradan animals in immunological comparisons of subgenera of *Spermophilus.* Skryja and Clark (1970) studied seasonal physiological changes in golden-mantled ground squirrels in southern Wyoming. The most complete study of the natural history of the species to date is that by McKeever (1964) in Lassen County, California.

Geographic variation in *S. lateralis* currently is under study by David T. Wright of the Museum of Natural History, University of Illinois.

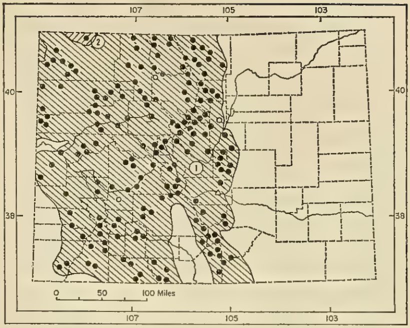


Fig. 48. Distribution of *Spermophilus lateralis* in Colorado. 1. *S. l. lateralis.* 2. *S. l. wortmani.* For explanation of symbols, see p. 9.

Spermophilus lateralis lateralis (Say)

S[ciurus]. lateralis Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 2:46, 1823; type locality, vicinity of Cañon City, Fremont Co., Colorado.

Spermophilus lateralis, Cuvier, Supplément à l'histoire naturelle générale et particulière de Buffon, 1:335, 1831.

Distribution in Colorado.—Western three-fifths of state (Fig. 48).

Comparison.—From *S. l. wortmani,* the subspecies of central Sweetwater County, Wyoming, and immediately adjacent Colorado, *S. l. lateralis* differs in generally brighter color, better-defined lateral stripes that are predominantly black rather than brown, slightly smaller skull, and slightly longer nasal bones.

Measurements.—Mean (and extreme) external measurements of five males, followed by those of eight females, all from Larimer and Boulder counties, are: 275.4 (269-294), 272.4 (246-285); 96.2 (88-116), 88.0 (74-97); 41.2 (40-43), 41.6 (38-44); 19.8 (16-22), 20.7 (18-23); mean weight of three males, 184.02 (173.5-197.4), of six females, 216.45 (187.8-286.5). External measurements of two males and two females from Two Bar Spring, Moffat County, are, respectively: 275, 271, 275, 285; 91, 84, 92, 91; 40, 44, 44, 45. Cranial measurements are presented in table 11.

Remarks.—Hall and Kelson (1959:362) noted parenthetically that Merriam (1905: 163) had fixed the type locality of *S. lateralis* at ". . . about 26 mi. below Canyon City. . . ." This note is an apparent error, inasmuch as the reference by Merriam was to the type locality of *Eutamias quadrivittatus* and *S. lateralis* was not mentioned by him. In the account of Long's expedition (James, 1823), there is no mention of a precise type locality for *S. lateralis,* and no implication that the type localities of *S. lateralis* and *E. quadrivittatus* were the same. Following a brief account of the habits of *E. quadrivittatus,* the type specimen of which was collected some 26 to 30 miles below the present site of Cañon City, it was noted that "there is also another species [of squirrel] inhabiting about the mountains . . ." (James, 1823, 2:46). The reference is to *S. lateralis,* and the mountains in which the expedition had last been were those near Cañon City. Hence, the vicinity of Cañon City, Fremont Co., Colorado, is a probable approximation of the type locality.

A specimen from a place 6 6/10 mi. W of Gunnison (CU 5368) is completely melanistic.

Records of occurrence.—Specimens examined, 782, distributed as follows: MOFFAT COUNTY: Escalante Hills, 20 mi. SE Ladore, 1 (USNM); *Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers],* 9 (DMNH); 2 mi. SE Greystone, 7 (CM); *Douglas Spring, 6700 ft.,* 6 (WC); *[Little] Snake River, lower bridge, 7 mi. above Lily,* 4 (WC); 5 mi. above Lily, 1 (WC); *[Little] Snake River,* 1 (DMNH); S bank Yampa River, 4 mi. NNW Cross Mountain, 6 (5 AMNH, 1 CM); *1 mi. SE Cross Mountain,* 1 (CM); 5 mi. SE Cross Mountain, 1 (CM); Mantle's Cave, Dinosaur National Monument, 1 (CU); 6 mi. SW Cross Mountain, 2 (CM). ROUTT COUNTY: Three Forks, 30 mi. above Baggs, Wyoming, 1 (AMNH); Hahn's Peak, 1 (USNM); *18 mi. below Steamboat Springs,* 1 (WC); 15 mi. W Steamboat Springs, 1 (USNM); Steamboat Springs, 6750 ft., 1 (WC); 6 1/2 mi. SW Oak Creek, 1 (CU); Toponas, 2 (1 CM, 1 DMNH); Crater [sec. 10, T. 1 S, R. 83 W], 1 (DMNH). JACKSON COUNTY: Pearl, 9000 ft., 1 (USNM); 7 mi. N Northgate, 1 (DMNH); *4 mi. N Northgate,* 3 (DMNH); Northgate, 3 (DMNH); Mount Zirkel, 2 (DMNH); Hell Creek, 1 (WC); *North Park,* 2 (USNM); *2 mi. N, 2 mi. E Gould, 8600 ft.,* 2 (KU); *Homestead Ranch,* 1 (DMNH); 3 mi. below Cameron Pass, 1 (WC); Arapaho Pass, 3 (USNM). LARIMER COUNTY: sec. 20, T. 11 N, R. 75 W, 10,100 ft., 1 (CSU); North Fork Cache la Poudre River, SE 1/4 sec. 20, T. 10 N, R. 71 W, 3 (1 CSC, 1 CSU, 1 CU); *Red Feather Lakes,* 1 (CSU); *1 mi. S, 20 mi. W Livermore, 8400 ft.,* 1 (KU); 2 mi. E Log Cabin, 2 (WC); *Manhattan,* 1 (CSU); *6 mi. SE Red Feather Lakes,* 1 (CSU); 13 1/2 mi. NW Fort Collins, 1 (CSU); *12 mi. NW Fort Collins,* 1 (CSU); *35 mi. [by road] W Laporte, 7500 ft.,* 1 (CSU); *2 mi. W Spencer Heights,* 1 (KU); *Indian Meadows, Poudre Cañon,* 1 (CSU); *42 mi. [by road] W Fort Collins, 8500 ft.,* 1 (CSU); Rawah Wild Area, 25 mi. W Rustic, 1 (CU); *60 mi. [by road] W Fort Collins,* 2 (CU); *70 mi. [by road] W Fort Collins, 9600 ft.,* 1 (CSU); Chambers Lake, 9200 ft., 5 (4 CSU, 1 CU); *near Chambers Lake,* 1 (WC); *Buckhorn Mountain,* 1 (CSU); *Buckhorn Ranger Station,* 1 (USNM); 10 mi. up Rist Canyon, sec. 23, T. 8 N, R. 71 W, 1 (CSU); sec. 26, T. 8 N, R. 73 W, 1 (CSU); *sec. 26, T. 8 N, R. 71 W,* 1 (CSU); *4 mi. N, 12 mi. W Fort Collins,* 2 (1 CSU, 1 CU); *2 mi. W Pennock Pass,* 1 (CSU); Pingree Park, 2 (1 CU, 1 KU); *4 1/2 mi. E Pingree Park,* 1 (CSU); 12 mi. S Fort Collins, 1 (CU); *Devil's Gulch, 6 mi. N Estes Park,* 1 (RMNP); *3 mi. W Estes Park, 8000 ft.,* 1 (UI); Estes Park, 24 (2 ANSP, 3 AMNH, 3 KU, 16 USNM); *5 mi. E Estes Park,* 1 (CSC); *2 1/2 mi. SW Estes Park,* 1 (KU); *E end Moraine Park,* 1 (RMNP); *3 1/2 mi. SW Estes Park,* 2 (KU); *Glacier Creek Picnic Ground,* 1 (RMNP); *4 1/2 mi. SW Estes Park,* 9 (KU); *3 mi. S, 3 mi. W Estes Park,* 1 (UI); *Bear Lake Road,* 1 (RMNP); *4 mi. S, 2 mi. W Estes Park,* 5 (KU); *8 mi. N Allenspark,* 2 (CU); *Longs Peak,* 2 (USNM); *Longs Peak, 9000 ft.,* 1 (USNM); *Longs Peak, timberline, about 10,500 ft.,* 1 (USNM); *no locality other than county,* 1 (CSU). RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 1 (USNM); 5 mi. S Pagoda Peak, 6 (KU); 5 mi. W Rangely, 1 (USNM); 7 mi. NE Meeker, 2 (CM); *6 mi. NE Meeker,* 1 (CM); Lost Creek, 9 mi. NE Buford, 5 (CM); Meeker, 1 (USNM); *Ute Creek, 8000 ft.,* 6 (AMNH); Marvine, 1 (USNM); *Marvine Lodge,* 1 (CU); *Dry Fork, White River, 6300 ft.,* 2 (AMNH); *Grand Hogback, 5 mi. S Meeker,* 1 (CM); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 9 (CM); *Big Beaver Creek,* 1 (WC); 26 mi. S Rangely, 1 (CM); Rio Blanco, 2 (USNM); *Piceance Creek, 2 mi. W Rio Blanco,* 1 (CU); *Compass Creek, 9000 ft.* (not found), 16 (AMNH). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 2 (CM); Rifle Mountain Park, 1 (CU); West Fork Elk Creek, 8 mi. above New Castle, 3 (WC); head Douglas Creek, 30 mi. S Rangely, 7700 ft., 6 (CM); 12 mi. above Glenwood Springs, 1 (WC); *W Fork Douglas Creek, 35 mi. S Rangely,* 5 (CM); *Atchee, 6600 ft.,* 2 (WC); 28 mi. N, 5 mi. W Mack, 7200 ft., 1 (KU); Glenwood Springs, 1 (CU); Rifle, 1 (USNM); *near Rifle,* 12 (DMNH); 20 mi. N Mack, 1 (CM); 12 mi. SE Rifle, 2 (FMNH). EAGLE COUNTY: Yarmany Creek, near McCoy, 6900 ft., 8 (2 AMNH, 6 WC); Allenton, 7200 ft., 3 (WC). GRAND COUNTY: Milner Pass, 3 (KU); Grand Lake, 8300 ft., 4 (1 AMNH, 3 WC); *3 mi. S, 2 mi. W Grand Lake,* 15 (UNM); Hot Sulphur Springs, 7665 ft., 5 (2 DMNH, 1 USNM, 2 WC); *Coulter, 8500 ft.,* 2 (USNM); Fraser, 1 (FWS); near Sheephorn Pass, 6 (1 AMNH, 1 USNM, 4 WC); *below Sheephorn Pass, 6800 ft.,* 1 (WC). SUMMIT

COUNTY: *west of Loveland Pass,* 2 (KU); Gray's Peak, 10 (KU); *Dillon,* 2 (UI); summit of Vail Pass, 1 (KU); Breckenridge, 1 (DMNH); Boreas Pass, 1 (WC); *Boreas,* 2 (WC). BOULDER COUNTY: 12 1/2 mi. S Estes Park, 1 (KU); Ward, 9500 ft., 1 (USNM); *1 mi. SW Ward,* 1 (FHSC); *3 mi. S Ward, 9000 ft.,* 4 (KU); *3 mi. S, 1/2 mi. E Ward,* 11 (KU); *2 mi. W Gold Hill,* 7 (KU); Gold Hill, 7 (USNM); *Science Lodge,* 3 (CU); *1/4 mi. E Science Lodge, 9500 ft.,* 1 (UI); *between Nederland and Science Lodge,* 1 (CU); *8 mi. NW Nederland,* 1 (CU); *10 mi. W Boulder,* 1 (CSC); Boulder, 4 (1 ANSP, 1 FMNH, 2 USNM); *South Boulder Canyon,* 1 (FWS); *8 mi. WSW Boulder,* 1 (KU); *Coal Creek Canyon,* 1 (FWS); Eldora, 11,000 ft., 1 (CU); 3 mi. E Pinecliff, 5 (DMNH); *Eldorado Springs,* 1 (FWS); *Boulder Pass* (not found), 1 (USNM). CLEAR CREEK COUNTY: 2 mi. S Berthoud Pass, 1 (KU); 2 2/10 mi. W Idaho Springs, 1 (UI); *Idaho City [Idaho Springs],* 4 (USNM); *Mill City,* 6 (4 AMNH, 2 FMNH); *near Idaho [Springs],* 2 (MCZ); *Georgetown,* 2 (CSU); *Graymount,* 2 (SC); East side Squaw Mountain, 2 (KU); Loveland Pass, 3 (2 FWS, 1 KU); Camp Lemon, 5 mi. above Silverplume, 1 (DMNH); *between Gray's and Torrey's peaks,* 1 (DMNH); *Evans Ranch, Brookvale,* 1 (DMNH); Echo Lake, 5 (DMNH); Mount Evans, 3 (CU). JEFFERSON COUNTY: Conifer, 1 (CSC); *2 mi. E Conifer,* 1 (CSC); *10 mi. N Pine,* 1 (UI); *no locality other than county,* 2 (1 DMNH, 1 USNM). MESA COUNTY: 2 mi. N, 9 mi. E Collbran, 7000 ft., 1 (KU); 4 mi. S, 2 mi. E Collbran, 6800 ft., 2 (KU); *4 mi. S, 3 mi. E Collbran, 6800 ft.,* 2 (KU); 9 mi. S, 3 mi. E Collbran, 10,200 ft., 6 (KU); Grand Junction, 1 (FMNH); Land's End, 3 (CU); *Glade Park, 8000 ft.,* 1 (FMNH); 9 mi. S Glade Park, 4 (2 AMNH, 2 CM); Piñon Mesa, 8000 ft., 2 (FMNH). PITKIN COUNTY: Aspen, 2 (DMNH); *4 mi. E Aspen,* 2 (CU); *Elk Mountains,* 1 (USNM); *13 mi. W Independence Pass, 10,000 ft.,* 1 (FMNH); Independence Pass, 11,500 ft., 1 (UI). LAKE COUNTY: 1/4 mi. N Leadville, 1 (CSC); *California Gulch, Cochetopa [San Isabel] National Forest,* 2 (USNM); 8 mi. SW Leadville, 1 (KU); *9 mi. SW Leadville,* 1 (KU); *11 mi. SW Leadville,* 3 (KU); *Dayton,* 2 (USNM); 13 mi. SW Leadville, 12,500 ft., 1 (KU). PARK COUNTY: 8 mi. NNW Grant, 10,000 ft., 3 (FWS); *6 mi. NNW Grant, 9200 ft.,* 1 (FWS); Grant, 2 (CU); *Hall Valley,* 3 (AMNH); *Call Valley [Hall Valley],* 3 (DMNH); Bailey, 2 (CU); *Montgomery,* 3 (MCZ); Buckskin Creek, above Alma, 1 (WC); *4 mi. W Alma,* 4 (FMNH); Tarryall Creek, 6 mi. above Puma City, 9400 ft., 1 (WC); Garo, 9500 ft., 1 (USNM); *12 mi. NNW Florissant, 9525 ft.,* 1 (KU); *no locality other than county,* 1 (UI). DOUGLAS COUNTY: 10 mi. SW Castle Rock, 1 (UMMZ); 2 mi. W Palmer Lake, 2 (DMNH). GUNNISON COUNTY: *Irwin,* 1 (KU); *1 mi. W Gothic,* 1 (UNM); Gothic, 6 (1 CSU, 2 KU, 1 UNM, 2 USNM); *Rocky Mountain Biological Laboratory, near Gothic,* 1 (UMMZ); Slate Creek Valley, 1 (AMNH); *3 mi. W Crested Butte,* 1 (WC); Crested Butte, 9000 ft., 9 (1 KU, 1 MCZ, 7 WC); Taylor Park, 2 (DMNH); Almont, 1 (AMNH); *Spring Creek,* 1 (USNM); *5 1/2 mi. N Parlin, 9100 ft.,* 1 (FWS); *7 1/2 mi. W Gunnison, 7050 ft.,* 3 (FWS); *6 6/10 mi. W Gunnison,* 1 (CU); *6 3/10 mi. W Gunnison,* 1 (WSC); Gunnison, 1 (UMMZ); *S of Gunnison,* 1 (WSC); *1 mi. WSW Gunnison,* 1 (WSC); *1/2 mi. S Tomichi Bridge on Gold Basin Road,* 1 (WSC); 8 mi. NW Sapinero, 9500 ft., 1 (USNM); Iola, 3 (DMNH); *1 mi. N Sargents,* 1 (WSC); *no locality other than county,* 1 (WC). CHAFFEE COUNTY: Buena Vista, 2 (UMMZ); Cottonwood Creek, 10,328 ft., 1 (WC); 9 mi. NNW Salida, 1 (KU); 1 1/2 mi. S Monarch, 4 (2 FMNH, 2 UI); 10 mi. SW Salida, 1 (KU); *1 mi. below Mears,* 1 (WC); near Poncha Pass, 1 (WC). TELLER COUNTY: Manitou Experimental Forest, 8000 ft., 2 (CSU); *7 mi. N Woodland Park, 9000 ft.,* 1 (CSU); 8 mi. NW Woodland Park, 1 (CSU); *9 mi. N Florissant, 8900 ft.,* 3 (FWS); Divide, 1 (WC); Oil Creek, 13 mi. SW Woodland Park, 9000 ft., 3 (2 CSU, 1 CU). EL PASO COUNTY: *Cascade, 8500 ft.,* 4 (USNM); *Manitou Park,* 3 (KU); *Halfway,* 1 (UMMZ); *Minnehaha,* 1 (UMMZ); Colorado Springs, 3 (2 MCZ, 1 WC); *Bear Creek Canyon, near Colorado Springs, 7100 ft.,* 3 (WC); *Hunter's Creek,* 1 (WC); *near Colorado Springs,* 1 (WC); Lake Moraine, 10,250 ft., 5 (2 AMNH, 1 MCZ, 2 WC). MONTROSE COUNTY: South Rim Headquarters, Black Canyon of the Gunnison National Monument, 3 (CU); *Grizzly Gulch,* 1 (CU); 10 mi. E Montrose, 1 (WSC); SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft., 1 (KU). OURAY COUNTY: Ouray, 10,450 ft., 1 (FWS); Ironton, 2 (SC); *Red Mountain, 10,500 ft.,* 3 (AMNH); *Red Mountain, 11,000 ft.,* 2 (AMNH); Red Mountain Pass, 2 (SC). SAN MIGUEL COUNTY: Norwood, 1 (DMNH); *4 mi. S Norwood, 7500 ft.,* 1 (CSU); Lone Cone Peak, 4 (SC). SAGUACHE COUNTY: Marshall Pass [S side of Ouray Peak], 10,846 ft., 1 (KU); 5 mi. SE Sargents, 1 (KU); W side Cochetopa Dome, Cochetopa Park, 1 (CSU); *5 mi. N, 22 mi. W Saguache, 10,000 ft.,* 2 (KU); 4 mi. N, 20 mi. W Saguache, 9500 ft., 1 (KU); Cochetopa Pass, 33 mi. W Saguache, 10,000 ft., 4 (KU); *Saguache Park,* 1 (USNM); 2 mi. N, 2 mi. E Crestone, 8300 ft., 1 (KU); near Herard Cabin, Medano Cañon, 3 (1 GSDNM, 2 WC); *Mosca Creek, 8200 ft.,* 2 (WC). FREMONT COUNTY: 5 mi. S Victor, 1 (UNM); 3 1/2 mi. S Coaldale, 2 (1 FMNH, 1 UI). CUSTER COUNTY: Westcliffe, 1 (USNM); *Silvercliff,* 1 (FWS); *1 1/2 mi. N, 1 1/2 mi. W Fairview,* 4 (KU); 7 mi. N Lake Isabel, 3 (CU); *Amethyst Creek, 8800 ft., 1 mi. above San Isabel City,* 1 (WC); San Isabel, 1 (SCSC). DOLORES COUNTY: Rico, 1 (USNM). SAN JUAN COUNTY: *Eureka,* 1 (UNM); *Silverton,* 4 (DMNH); Molas Pass, 1 (SC). HINSDALE COUNTY: Lake City, 2 (USNM); 7 mi. S, 2 mi. W Lake City, 9000 ft., 3 (KU); Hermit, 2 (USNM). MINERAL COUNTY: 3 mi. E Creede, 2 (KU); *4 mi S, 4 mi. W Creede, 8800 ft.,* 3 (KU); 3 mi. N Spar City, 8800 ft., 2 (KU); Wagon Wheel Gap, 9000 ft., 1 (WC). ALAMOSA COUNTY: Mosca Pass, 1 (KU); 22 mi. E Mosca, 2 (1 AMNH, 1 USNM).

HUERFANO COUNTY: 6 mi. W Redwing, 2 (KU); La Veta Pass, 5 (USNM); 5 mi. S, 1 mi. W Cucharas Camps, 6 (KU); East Spanish Peak, 11,300 ft., 1 (CU). MONTEZUMA COUNTY: Mancos, 1 (SC); head East Fork Navajo Canyon, 7900 ft., Mesa Verde National Park, 1 (KU); Mesa Verde National Park, 1 (CU). LA PLATA COUNTY: 35 mi. N Bayfield, 2 (USNM); Electra Lake, 2 (UNM); 21 mi. N Bayfield, 8 (USNM); Durango, 3 (1 AMNH, 1 ASC, 1 FMNH); Florida, 31 (26 AMNH, 5 FMNH). ARCHULETA COUNTY: Gordon Creek near junction with Piedra River, 4 (UNM); Pagosa Springs, 4 (3 USNM, 1 WC); Navajo River, 17 (1 AMNH, 16 DMNH); Chromo, 8 (3 AMNH, 3 DMNH, 2 UI). CONEJOS COUNTY: 1 mi. SW Platoro, 1 (FHSC); *Conejos Cañon,* 1 (ASC); *26 mi. SW Alamosa,* 1 (ASC); 12 mi. NE Cumbres, 9 (1 AMNH, 8 USNM); 5 mi. S, 24 mi. W Antonito, 3 (KU); Osier, 3 (DMNH). COSTILLA COUNTY: 15 mi. N Trinchera Peak, 3 (USNM); Fort Garland, 1 (MCZ); *"Garland,"* 1 (USNM); 5 mi. N Trinchera Peak, 3 (USNM); Culebra Cañon, 9100 ft., 2 (WC). County unknown: *Chief Mountain Lake,* 1 (AMNH); *Sangre de Cristo,* 1 (USNM); *Fish Creek,* 2 (USNM); *Jackson Ranger Station,* 4 (SC).

Additional records: LARIMER COUNTY: *North Fork Cache la Poudre River, 9500 ft.* (Gordon, 1938: 78). GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53); near Berthoud's Pass (Coues and Yarrow, 1875:119). JEFFERSON COUNTY: Evergreen (A. H. Howell, 1938:194). LAKE COUNTY: *Twin Lakes* (Coues and Yarrow, *loc. cit.*). PARK COUNTY: Mount Lincoln (Blake and Blake, 1969:36). GUNNISON COUNTY (Durrant and Robinson, 1962:247, unless otherwise noted): *1 mi. NNE Gothic, 9600 ft.* (Findley and Negus, 1953:237); *9/10 mi. NW Gothic, 9700 ft.* (Findley and Negus, *loc. cit.*); *7/10 mi. NNE Gothic, 10,500 ft.* (Findley and Negus, *loc. cit.*); *3/10 mi. NW Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *Dry Gulch, 1 1/2 mi. above Gunnison River, 8000 ft.; Gunnison River, river-mile 55 2/10, 7600 ft.; confluence of Beaver Creek and Gunnison River, 7600 ft.; Dry Gulch, 3/4 mi. above Gunnison River, 7460 ft.; 3 mi. NE Cimarron, 7700 ft.; 2 mi. NE Cimarron, 7150 ft.; Black Canyon of the Gunnison, 8 mi. W Sapinero, 7500 ft.; Black Canyon of the Gunnison, 5 mi. W Sapinero, 7500 ft., 5 mi. above mouth of Lake Fork, 7400 ft.;* 5 1/2 mi. above mouth of Lake Fork, 7460 ft. FREMONT COUNTY: type locality, probably vicinity of Cañon City (Say, *in* James, 1823, 2:46).

Spermophilus lateralis wortmani (J. A. Allen)

Tamias wortmani J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:335, 8 November 1895; type locality, Kinney Ranch, Bitter Creek, Sweetwater Co., Wyoming.

Spermophilus lateralis wortmani, Hall and Kelson, The mammals of North America, Ronald Press, New York, 1:363, 31 March 1959.

Distribution in Colorado.—Known only from extreme northern Moffat County (Fig. 48).

Comparison.—For comparison with *S. l. lateralis,* see account of that subspecies.

Measurements.—I have measured no adults of this subspecies from Colorado. Mean (and extreme) external and cranial measurements (from A. H. Howell, 1938:195) of six adults (two males, four females) from the type locality are: 280 (271-289), 95 (87-101), 43.2 (41-44), 17.1 (16-18); greatest length of skull, 44.1 (43.4-46.0); zygomatic breadth, 27.9 (27.4-28.5); postorbital constriction, 13.0 (12.5-13.8); length of nasals, 15.6 (15.2-16.2); length of maxillary toothrow, 8.7 (8.3-9.1).

Remarks.—Cary (1907b) referred to *S. l. wortmani* a specimen captured on the north side of the Little Snake River, 20 miles below Bagg's Crossing, Carbon Co., Wyoming. Cary (1911:84) also referred specimens from above Lily to *wortmani,* and A. H. Howell (1938: 195) adopted that arrangement.

The only Colorado-taken specimen of *S. lateralis* examined that seems to me clearly referable to *wortmani* is the above-mentioned specimen from along the Little Snake River below Baggs (USNM 147997). Specimens from elsewhere in Moffat County—above Lily, from Douglas Spring, and from Two Bar Spring—are pale in overall color, but have predominantly black rather than brown lateral stripes, and have skulls similar to those of the populations referred to *lateralis.* Durrant and Hansen (1955:137) came to comparable conclusions. The specimen from below Baggs was considered by those authors to be an intergrade between *lateralis* and *wortmani,* but referable to the latter subspecies.

Apparently nowhere in the lower Yampa River drainage are individuals as consistently bright as elsewhere in Colorado. In particular, many specimens from Moffat County lack the extensive rusty "mantle" prominent in specimens from the upper Colorado River drainage.

Records of occurrence.—Specimens examined, 1, as follows: MOFFAT COUNTY: [Little] Snake River, 20 mi. [WS]W Baggs, Wyoming, 1 (USNM).

Cynomys ludovicianus

Black-tailed Prairie Dog

Cynomys ludovicianus is a mammal of the Great Plains. In Colorado, the species occupies areas of short- and mixed-grass prairie, and occurs throughout the eastern part of the state. Only locally does the species find access to grasslands of the foothills. The highest locality of record is Conifer, on Turkey Creek in Jefferson County, 7300 feet. More typically the upper limit is about 6000 feet.

Because of their conspicuous "towns" and their obvious effects on the grassland vegetation, prairie dogs long have been the object of stringent control efforts. Early in the present century, it was estimated that two per cent of the area of eastern Colorado was occupied by prairie dog towns, a loss of some 412 square miles of rangeland (Payne, 1903; S. A. Johnson, 1912). The Office of the State Entomologist was charged with responsibility for pest control under the so-called "Pest Inspection Act" of 1911. For reports of the work of this agency in the control of prairie dogs, the interested reader is directed to the Annual Reports and Circulars of the State Entomologist, beginning in 1912. Burnett (1913, 1915) presented detailed notes on the distribution of Coloradan prairie dogs.

For details of natural history of species of *Cynomys* in Colorado, see the extensive accounts in Lechleitner (1969). An excellent study of prairie dogs and their relationship to range ecology was presented by Koford (1958). Parts of that study were conducted in north-central Colorado. Scheffer (1947) commented briefly on the autecology of *C. ludovicianus* and *C. gunnisoni*. Tileston and Lechleitner (1966) compared *C. ludovicianus* and *C. leucurus*. Waring (1966b, 1970) reported comparative studies of alarm behavior and vocal communication of Coloradan species of *Cynomys*. Nadler and Harris (1967) described the karyotype of *C. ludovicianus*, and Rapp (1962) reported fleas from the black-tailed prairie dog in Crowley County.

I have noted no albinism in prairie dogs from Colorado, although Tate (1947) reported an albino from Trinidad.

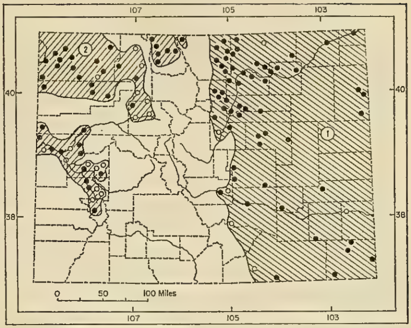


Fig. 49. Distribution of two species of prairie dogs in Colorado. 1. *Cynomys ludovicianus ludovicianus.* 2. *Cynomys leucurus.* For explanation of symbols, see p. 9.

Cynomys ludovicianus ludovicianus (Ord)

Arctomys ludovicianus Ord, *in* Guthrie, A new geographical, historical and commercial grammar . . . , 2nd Amer. ed., Philadelphia, 2:292, 1815; type locality restricted by Jones (1964:138) to lower slope of the "Tower," sec. 10, T. 34 N, R. 10 W, Boyd Co., Nebraska.

Cynomys ludovicianus, Baird, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1): 331, 14 July 1858.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 49).

Measurements. — Average (and extreme) external measurements of 10 males, followed by those of eight females, all from eastern Larimer County, are: 378.7 (358-400), 371.4 (340-400); 82.2 (71-95), 75.0 (60-84); 60.5 (57-63), 61.0 (55-63); 14.2 (12-17), 14.5 (11-18); mean weight of eight males, 785.0 (575-950), and of five females, 899.0 (785-1030). For cranial measurements, see table 12.

Records of occurrence.—Specimens examined, 271, distributed as follows: LARIMER COUNTY: near Round Butte, 3 (CSU); 13 mi. WNW Fort Collins, 1 (CSU); *13 mi. N Fort Collins,* 2 (CSU); *12 mi. N Fort Collins,* 1 (CSU); *3 mi. NW Waverly,* 1 (CSU); *13 mi. NNW Fort Collins,* 1 (CSU); *10 mi. N Fort Collins,* 2 (CSU); *9 mi. N, 1 mi. E Fort Collins,* 2 (CSU); *Fuqua, 12 mi. NW Fort Collins,* 20 (CSU); *Wellington,* 1 (CSU); *9 1/2 mi. NW Fort Collins,* 1 (CSU); *8 1/2 mi. NE Fort Collins,* 1 (CSU); *6 mi. N Fort Collins,* 2 (CSU); *5 mi. N, 2 mi. W Fort Collins,* 1 (CSU); *NW of Fort Collins,* 1 (CSU); 7 mi. W Fort Collins, 2 (CSU); *2 mi. W*

TABLE 12

Selected cranial measurements of three species of *Cynomys*.

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Postorbital constriction	Length of nasals	Length of maxillary toothrow	Mastoid breadth
Cynomys ludovicianus ludovicianus, Larimer County							
Mean, 17 ♂	64.02	61.40	45.20	13.29	22.91	16.12	29.73
Minimum	62.0	59.5	43.6	12.9	22.8	15.2	26.9
Maximum	67.8	64.4	48.5	15.0	25.6	18.1	30.3
Mean, 17 ♀	63.09	59.98	44.71	13.42	23.58	16.54	28.24
Minimum	60.5	57.4	42.6	12.3	21.9	15.4	26.6
Maximum	66.0	62.3	48.0	14.7	25.0	17.4	29.7
Cynomys leucurus, Mesa County							
Mean, 5 ♀	——	57.84	43.78	13.26	21.52	15.48	27.60
Minimum	——	57.1	43.3	12.8	21.1	15.2	26.9
Maximum	——	58.6	44.0	13.6	22.0	15.6	28.1
USNM 54111, ♂	——	61.2	44.7	14.0	22.5	15.6	30.1
North Park, Jackson County							
Mean, 8 ♂	63.05	60.40	45.20	13.29	22.91	16.12	29.73
Minimum	62.5	59.9	43.6	12.6	22.5	15.6	28.5
Maximum	64.1	61.6	46.0	14.2	23.2	16.5	30.8
Mean, 8 ♀	61.12	58.73	43.63	13.32	21.61	15.76	28.95
Minimum	59.9	57.6	42.7	12.3	20.8	15.5	28.0
Maximum	62.2	59.9	44.3	14.3	22.0	16.2	30.4
Cynomys gunnisoni gunnisoni, San Luis Valley and Saguache Creek watershed							
Mean, 12 ♂	——	56.01	42.87	13.35	21.36	14.72	27.31
Minimum	——	53.6	30.5	12.9	20.6	14.2	25.9
Maximum	——	57.7	44.2	13.7	23.0	15.1	28.6
Chaffee County							
CSU 11089, ♀	58.9	56.3	41.2	13.5	20.7	15.7	26.7
CSU 9192, ♀	55.5	53.2	40.7	13.9	19.4	14.9	25.9
Cynomys gunnisoni zuniensis, Montezuma County							
Mean, 4 ♂	61.33	58.75	43.83	13.78	22.20	14.98	28.72
Minimum	60.3	57.8	42.0	11.7	21.6	14.7	27.8
Maximum	64.0	61.1	45.4	15.4	22.6	15.7	30.1
Mean, 4 ♀	59.20	56.48	41.90	13.55	21.42	14.85	27.18
Minimum	58.0	55.4	40.8	13.2	21.0	14.5	26.5
Maximum	60.8	58.0	42.4	13.9	22.0	15.1	27.6

Fort Collins, 1 (CSU); *W of Fort Collins,* 1 (CSU); Fort Collins, 1 (CSU); *SW of Fort Collins,* 10 (CSU); *1 mi. S, 3 mi. W Fort Collins,* 2 (CSU); *1 mi. S Fort Collins,* 1 (CSU); *2 mi. SW Fort Collins,* 2 (CSU); *1 1/2 mi. S Fort Collins,* 1 (CSU); *3 mi. S Fort Collins,* 4 (CSU); *3 3/4 mi. SW Fort Collins,* 1 (CSU); *3 mi. S, 2 mi. W Fort Collins,* 1 (CSU); *4 mi. SW Fort Collins,* 10 (CSU); *1 1/2 mi. NNE Timnath,* 1 (CSU); *1 mi. N, 1 mi. E Timnath,* 1 (CSU); *4 1/2 mi. SW Fort Collins,* 1 (CSU); *W of Timnath Reservoir,* 1 (CSU); *4 mi. S Fort Collins,* 2 (CSU); 3/10 mi. N, 3/10 mi. E Timnath, 1 (CSU); *4 1/2 mi. S, 3 mi. W Fort Collins,* 1 (CSU); *4 1/2 mi. S, 3 1/2 mi. E Fort Collins,* 1 (CSU); *5 mi. SW Fort Collins,* 6 (CSU); *5 6/10 mi. SW Fort Collins,* 1 (CSU); *5 1/4 mi. SSW Fort Collins,* 1 (CSU); *5 mi. S, 1 mi. W Fort Collins, 5250 ft.,* 1 (CSU); *5 mi. S Fort Collins,* 2 (CSU); *6 1/2 mi. SW Fort Collins,* 2 (CSU); *6 7/10 mi. SW Fort Collins,* 2 (CSU); *7 mi. SW Fort Collins,* 1 (CSU); *6 mi. S, 2 mi. W Fort*

Collins, 6 (CSU); *6 mi. S Fort Collins,* 4 (CSU); *7 mi. S Fort Collins,* 1 (CSU); *4 mi. N Loveland,* 1 (CSU); Loveland, 3 (USNM); *Dogtown LR-4* (not found), 1 (CSU); *no locality other than county,* 4 (AMNH). WELD COUNTY: Rockport, 5 (DMNH); 9 mi. N Nunn, 5700 ft., 1 (CSU); *12 mi. NE Wellington,* 1 (CSU); *10 mi. NE Wellington,* 4 (CSU); 3 mi. N, 5 mi. W Nunn, 2 (CSU); 1 1/4 mi. NE Stoneham, 1 (CSU); Cornish, 3 (SC); 3 mi. SE Windsor, 1 (CSU); Greasewood Lake, 8 (DMNH); *Greasewood,* 1 (DMNH); *2 mi. N, 2 mi. W Greeley,* 1 (CSC); 1 mi. SW Greeley, 1 (CSC); *1 mi. S, 3 mi. W Greeley,* 1 (CSC); *N of Hardin,* 1 (DMNH); 8 1/2 mi. E Kersey, 1 (CSC); Empire Reservoir, 3 (DMNH); 1 mi. E Mead, 1 (UI); Platteville, 1 (DMNH). MORGAN COUNTY: 11 mi. N, 3 mi. W Fort Morgan, 1 (CSU); Jackson Reservoir, 24 (DMNH); *Goodrich,* 2 (DMNH); *Orchard,* 3 (DMNH); NW of Snyder, 1 (SC); *no locality other than county,* 1 (FMNH). LOGAN COUNTY: 12 mi. NE Sterling, 1 (CSU). SEDGWICK COUNTY: Julesburg, 1 (CSU). BOULDER COUNTY: 10 mi. N Boulder, 2 (WC); 7 3/10 mi. NE Boulder, 1 (CU); *2 mi. W Boulder Reservoir,* 2 (CU); *1/4 mi. E Boulder Reservoir,* 1 (CSC); *1 mi. N, 2 mi. E Boulder,* 1 (CSU); *N of Boulder,* 1 (CU); *near Boulder,* 1 (CU); *Boulder,* 3 (1 FMNH, 2 FWS); Broomfield, 1 (FWS); *no locality other than county,* 1 (USNM). JEFFERSON COUNTY: Semper, 1 (DMNH); Conifer, 7300 ft., 3 (USNM). ADAMS COUNTY: *N of Denver,* 1 (CSU); 10 mi. E Denver, 3 (SC); Watkins, 2 (DMNH); *no locality other than county,* 16 (12 AMNH, 4 DMNH). DENVER COUNTY: Denver, 4 (1 DMNH, 2 FWS, 1 USNM). ARAPAHOE COUNTY: Strasburg, 1 (UI); 7 mi. E Cherry Creek Dam, 2 (CU). YUMA COUNTY: Wray, 1 (DMNH); 28 mi. NW St. Francis, Kansas, 1 (KU); Idalia, 1 (SC). DOUGLAS COUNTY: 2 mi. N Louviers, 1 (CSU). ELBERT COUNTY: 10 mi. E Kiowa, 1 (FWS); 4 mi. S, 4 mi. E Kiowa, 1 (CSU); 5 mi. WSW Limon, 1 (UI); 3 mi. S Fondis, 1 (UMMZ); *no locality other than county,* 1 (DMNH). EL PASO COUNTY: near Colorado Springs, 1 (WC); *NW of Colorado City,* 1 (MCZ); *7 mi. S Colorado Springs,* 1 (UMMZ); 13 mi. S Colorado Springs, 1 (CSU); 16 mi. E Wigwam, 1 (SC). FREMONT COUNTY: Rockvale, 4 (FMNH). PUEBLO COUNTY: Pueblo, 1 (USNM). CROWLEY COUNTY: Olney [Springs], 4 (USNM). KIOWA COUNTY: 1 mi. E Haswell, 1 (CSU). BENT COUNTY: Ninaview, 1 (DMNH). LAS ANIMAS COUNTY: Trinchera, 1 (DMNH). BACA COUNTY: 1/2 mi. E Two Buttes Reservoir, 1 (CSU); N of Springfield, 2 (WC); Monon, 2 (WC); Regnier, 2 (DMNH). County unknown: *Don Carlos,* 1 (USNM).

Additional records: LARIMER COUNTY: *Trilby* (Markham, 1907:146). WELD COUNTY: Grover (Markham, *loc. cit.*); *Nunn* (Koford, 1958:6). JEFFERSON COUNTY: Dawson Station (Burnett, 1915:4). FREMONT COUNTY (Lechleitner, 1969: 89): Penrose; *Florence.* PUEBLO COUNTY: *Greenhorn Mountains* (Baird, 1858:331). PROWERS COUNTY: Lamar (Sanford Museum, Cherokee, Iowa, J. B. Bowles, personal communication). LAS ANIMAS COUNTY: Trinidad (Tate, 1947:62). County unknown: *Soda Springs* (Allen, *in* Coues and Allen, 1877:901).

For detailed lists of non-marginal records of occurrence based on complaints of land-owners, see Burnett (1913, 1915).

Cynomys leucurus

White-tailed Prairie Dog

Cynomys leucurus is primarily a species of the Wyoming Basin, and in Colorado typically inhabits xeric sites with mixed stands of shrubs and grasses. Most records of occurrence are below 8500 feet, but Lechleitner (1969:90) reported a specimen from the Grand Mesa at an elevation of more than 10,000 feet (labelled and reported herein as from "35 mi. E Grand Junction").

Social organization is loose among white-tailed prairie dogs relative to that seen in *C. ludovicianus.* Tileston and Lechleitner (1966) compared the ecology of *C. leucurus* and *C. ludovicianus* in Larimer County. Waring (1966b, 1970) reported comparative studies of alarm behavior and vocalization, Erpino (1968) described observations on copulation, and Clark (1968b) discussed environmental factors involved in behavorial periodicity. The latter two studies were made in the Laramie Basin of Albany County, Wyoming. Clark, *et al.* (1971) presented a detailed review of the biology of *C. leucurus.*

Cynomys leucurus Merriam

Cynomys leucurus Merriam, N. Amer. Fauna, 4:33, 8 October 1890; type locality, Fort Bridger, Uinta Co., Wyoming.

Distribution in Colorado.—Drainage of Laramie River, western Larimer County; North Park; northwestern part of state, north of Roan Plateau; valleys of Colorado River and major tributaries (Fig. 49).

Measurements.—Mean (and extreme) external measurements of eight males, followed by those of eight females, all from Jackson County, are: 371.0 (352-390), 354.6 (326-375); 56.0 (50-70), 52.4 (46-60); 58.9 (52-63), 56.3 (53-59); 14.2 (10-18), 14.9 (13-17); weight, 1238.7 (850-1675), 868.4 (705-1050). Representative cranial measurements are presented in table 12.

Remarks.—Cary (1911:95) observed that "the ranges of *gunnisoni* and *leucurus* do not seem to meet at any point, although separated by only a very narrow strip of country in the Cimarron region." Lechleitner (1969:91) reported the sympatry of the two species, apparently only recently established, in Delta, Montrose, and Ouray counties. A narrow zone of apparent hybridization was described where the ranges of the species overlap.

I have undertaken no detailed analysis of the populations in this zone. Preliminary study indicates a need for intensive field and laboratory investigation of the problem. Mr. J. J. Pizzimenti of the Museum of Natural History, University of Kansas, currently is engaged in biosystematic studies of the populations involved.

Cursory examination of most of the specimens from the zone of apparent sympatry would lead one to identify them as *C. gunnisoni,* which species they more closely resemble in dorsal color, facial pattern, and the pattern of the tail. Details of cranial morphology and overall cranial size are equivocal, but tend toward identification with *leucurus.* Specimens from the area in question are herein referred to *C. leucurus* on the strength of preliminary data on karyology and electrophoretic patterns furnished me by J. J. Pizzimenti. However, the problematic specimens examined are segregated in a separate list, below.

Records of occurrence.—*Specimens examined,* 230, distributed as follows: MOFFAT COUNTY: 16 mi. N Craig, 6600 ft., 1 (KU); 20 mi. NW Sunbeam, 1 (CM); Escalante Hills, 20 mi. SE Ladore, 1 (USNM); between Sand Creek and [Little] Snake River, 1 (WC); 2 mi. SE Greystone, 1 (CM); *Douglas Spring, 6700 ft.,* 1 (WC); *3 mi. E Lay,* 1 (DMNH); S of Lay, 1 (DMNH); near Pat's Hole, Pot Creek, 1 (DMNH); *Castle Park, Dinosaur National Monument,* 3 (CU); Cross Mountain, 3 (1 DMNH, 2 FMNH); 9 mi. SW Craig, 5 (CM); Coyote Basin, 6300 ft., 1 (WC); 1 mi. S Artesia [Dinosaur], 1 (CSU). ROUTT COUNTY: 6 mi. E Hayden, 1 (USNM); near Oak Creek, 7600 ft., 2 (AMNH); *no locality other than county,* 5 (3 AMNH, 2 DMNH). JACKSON COUNTY: S of Pearl, 2 (CSU); *17 mi. W Cowdry,* 13 (CSU); Boettcher Lake, 5 (DMNH); Canadian Creek, 2 (USNM); *10 mi. W Walden,* 9 (CSU); *Brownlee Ranch, 4 mi. N Walden,* 24 (CSU); *3 mi. N Walden,* 3 (CSU); *2 mi. N Walden,* 11 (CSU); *4 mi. W Walden,* 1 (CSU); *W of Walden,* 1 (CSU); *North Platte River, W of Walden,* 14 (CSU); Walden, 3 (DMNH); North Delany Butte Lake, 8100 ft., 5 (CSU); *1/2 N cutoff to Humbert Ranch, sec. 33, T. 9 N, R. 80 W,* 5 (CSU); *Humbert Ranch,* 1 (CSU); *Humbert Study Area,* 5 (CSU); *Butte Lake, sec. 35, T. 9 N, R. 81 W,* 1 (CSU); *Delany Butte,* 1 (CSU); Hebron, 1 (USNM). LARIMER COUNTY: Chimney Rock Ranch, [S]W of Tie Siding, Wyoming, T. 12 N, R. 75 W, 6 (CSU). RIO BLANCO COUNTY: 12 mi. N Meeker, 1 (USNM); *between Axial and Meeker,* 3 (CU); Rangely, 10 (DMNH); *Douglas Creek, 3 mi. S Rangely,* 1 (CM); *White River, near Meeker,* 3 (AMNH); Meeker, 6200 ft., 3 (2 USNM, 1 WC); *White River, 6000 ft.,* 12 (AMNH); Buford, 8500 ft., 1 (USNM); *Beaver Creek, 6800 ft.,* 1 (WC). GARFIELD COUNTY: 14 mi. N, 5 mi. W Mack, 5600 ft., 1 (KU); U.S. highways 6-24, 3 mi. N Mesa County line, 4 (CSU). EAGLE COUNTY: 20 mi. SW Toponas, 1 (DMNH). MESA COUNTY: 8 mi. NW Mack, Badger Wash, 3 (CSU); Mesa, 1 (FMNH); 1 mi. SW Fruita, 2 (DMNH); Grand Junction, 30 (3 CSU, 13 FMNH, 14 USNM); 35 mi. E Grand Junction, 1 (CSU). DELTA COUNTY: Eckert [Orchard City], 1 (SC); Delta, 2 (1 DMNH, 1 SC); Crawford, 1 (WC). MONTROSE COUNTY: Olathe, 1 (DMNH); Montrose, 4 (SC).

Additional records (Burnett, 1913:6, unless otherwise noted): MOFFAT COUNTY: *between Craig and Kelley's* (Hollister, 1916:24); Axial. ROUTT COUNTY: Hahn's Peak (Burnett, 1915:7); Steamboat Springs; Egeria Park (Cary, 1911:97). JACKSON COUNTY: Hell Creek (Hollister, *loc. cit.*). EAGLE COUNTY (Cary, 1911:97): McCoy; Wolcott; Gypsum. MESA COUNTY: Palisade; 1/2 mi. S Fruita (P. H. Miller, 1964:45); 1/4 mi. above Upper Fruita Canyon Tunnel, 5300 ft. (P. H. Miller, *loc. cit.*); Whitewater. DELTA COUNTY: Cedaredge (Burnett, 1915:8); Paonia (Cary, 1911:97); *Hotchkiss* (Cary, *loc. cit.*). MONTROSE COUNTY: Cedar Creek, Cerro Ridge. OURAY COUNTY: Colona; "Dallas Creek, a few miles west of Ridgway" (Cary, *loc. cit.*); Ridgway.

Specimens of uncertain specific assignment examined from an area of contact between *C. leucurus* and *C. gunnisoni* in west-central Colorado are as follows (not mapped): DELTA COUNTY: *SW of Paonia,* 6 (CSU); *2 mi. SE Paonia,* 2 (CSU); *6 mi. W Hotchkiss,* 2 (CSU); *5 mi. NW Crawford,* 1 (CSU); *4 mi. N junction Colorado Highway 92 and Crawford-Paonia Road,* 5 (CSU). MONTROSE COUNTY: *6 mi. E Montrose,* 3 (CSU); *2 9/10 mi. W Cimarron,* 1 (CSU); *Cimarron,* 14 (CSU); 10 mi. S Montrose, 3 (CSU).

Cynomys gunnisoni

GUNNISON'S PRAIRIE DOG

In central Colorado, Gunnison's prairie dog is typically a mammal of the mountain parks, occurring in sites ranging in elevation from about 6000 to 12,000 feet. In southwestern Colorado and adjacent areas, lower, more xeric habitats are utilized—sites comparable to those inhabited by *Cynomys leucurus* farther north.

Cynomys gunnisoni is the smallest of Coloradan prairie dogs. Superficially, Gunnison's prairie dog and the white-tailed prairie dog are similar, but they differ in average size, color, and cranial details, as well as in habitat preferences and details of social organization (see Lechleitner, 1969).

Burnett and McCampell (1926a) discussed the natural history of the southwestern subspecies, *C. g. zuniensis*. Longhurst (1944) studied ecology of the nominate race in the San Luis Valley. Scheffer (1947) compared the autecology of *C. gunnisoni* and *C. ludovicianus*. Variation in the breeding season with elevation in the vicinity of Norwood was discussed by Aldous (1935).

About 1945, sylvatic plague became epizootic in South Park and populations of *C. gunnisoni* were seriously affected. Originally the plague had two foci, southeast of Hartsel and southwest of Fairplay. The epizootic spread across South Park in two years; in less than four years, prairie dogs were virtually eliminated from some 670,000 acres (Ecke and Johnson, 1950; Fitzgerald, 1969). Lechleitner *et al.* (1962), Kartman *et al.* (1962), and Lechleitner *et al.* (1968) discussed the epizootic in detail and provided a thorough review of the literature.

Cynomys gunnisoni gunnisoni (Baird)

Spermophilus gunnisoni Baird, Proc. Acad. Nat. Sci. Philadelphia, 7:334, April 1855; type locality, Cochetopa Pass, Saguache Co., Colorado.

Cynomys gunnisoni, Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):335, 14 July 1858.

Distribution in Colorado.—Mountain parks and valleys of west-central and south-central parts of state (Fig. 50).

Comparison.—From *C. g. zuniensis*, the subspecies of extreme southwestern Colorado and adjacent areas, *C. g. gunnisoni* differs in smaller average external and cranial size and darker, more buffy (less pinkish-cinnamon) color.

Measurements.—Average (and extreme) external measurements of 12 males from the San Luis Valley and Saguache Creek watershed are: 350.4 (330-385), 59.0 (45-69), 56.3 (52-59). External measurements of two females from Chaffee County are: 330, 320; 56, 50; 49, 51; —, 12; weights, 940, 575. Selected cranial measurements are presented in table 12.

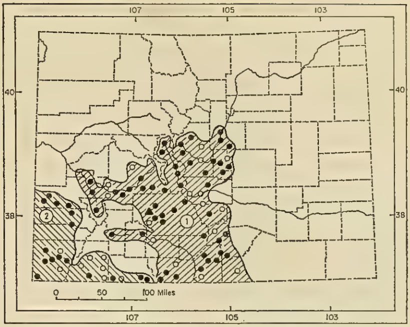


FIG. 50. Distribution of *Cynomys gunnisoni* in Colorado. 1. *C. g. gunnisoni*. 2. *C. g. zuniensis*. For explanation of symbols, see p. 9.

Remarks.—The ranges of *C. gunnisoni* and *C. ludovicianus* are essentially complementary along the eastern mountain front. This fact was noted first by J. A. Allen (1874:57) who remarked that *C. gunnisoni* was "common in South Park, and thence eastward to the plains, where it is immediately replaced by *Cynomys ludovicianus*."

The ranges of the two species approach each other at several places, but I know of no locality where they occur sympatrically. According to W. L. Burnett (paraphrased by Warren, 1942:137), ". . . near Badito, Huerfano County, colonies of two species are found within a mile of each other; *ludovicianus* occupying the flat along the Huerfano River, and *gunnisoni* the open parks among the piñons on the first benches south of the river and only a few hundred feet above it." The ranges of the two also approach each other in the South Platte drainage in Jefferson and Douglas counties, and in the vicinity of Colorado Springs.

Elliot (1907:182) reported as *C. gunnisoni* a specimen from Boulder County, supposedly in the Field Museum of Natural History. I have examined a single specimen of *Cynomys* from Boulder County in that collection and, as one would expect, it represents *C. ludovicianus.*

Burnett (1913:6 and 1915:8) reported *C. gunnisoni* from Cañon City and Florence, Fremont County, on the strength of complaints from landowners. I doubt that *C. gunnisoni* occurred in the immediate vicinity of Cañon City. Perhaps Burnett also doubted the report, because Cañon City was not mapped by him (1913:7) within the range of any species of prairie dog. The habitat in that area today is marginal for prairie dogs, but *C. ludovicianus* might be expected there occasionally. The black-tailed prairie dog does occur today at Florence (Lechleitner, 1969: 89), and I have seen specimens from Rockvale.

For comments on supposed hybridization between *C. gunnisoni* and *C. leucurus* noted by Lechleitner (1969:91), see the account of the latter species.

Records of occurrence.—Specimens examined, 207, distributed as follows: JEFFERSON COUNTY: Twin Creek [Twin Forks?], 1 (MCZ). LAKE COUNTY: Leadville, 1 (UMMZ); *12 mi. S Leadville,* 1 (UMMZ); Twin Lakes, 1 (USNM). PARK COUNTY: Jefferson, 5 (3 DMNH, 1 FWS, 1 SC); Alma, 1 (CSU); Western [Weston?] Ranch, Fairplay, 1 (USNM); *Tarryall River,* 10 (DMNH); 8 mi. S Fairplay, 10 (CSU); Lake Antero, 2 (DMNH); 5 mi. SW Guffey, 1 (CU); *South Park,* 9 (DMNH); *no locality other than county,* 13 (MCZ). DOUGLAS COUNTY: 3 mi. E Deckers, 1 (CSU); *sec. 14, T. 10 S, R. 67 W,* 1 (CSU); sec. 31, T. 10 S, R. 66 W, 1 (CSU). GUNNISON COUNTY: Almont, 1 (AMNH); 3 mi. W Gunnison, 2 (CSU); 3 mi. E Parlin, 8000 ft., 2 (FWS); *Steuben Creek, Iola,* 1 (DMNH); 14 6/10 mi. E Cimarron, 2 (CSU); *Cebolla,* 1 (DMNH); 12 mi. WSW Gunnison, 7500 ft., 1 (WSC); *4 mi. W Sapinero,* 1 (CSU); 7 mi. E Doyleville, 1 (CSU). CHAFFEE COUNTY: SE of Buena Vista, 7 (CSU); 1/2 mi. N Nathrop, 1 (CSU); *N of Salida,* 2 (CSU); Salida, 5 (1 AMNH, 4 WC); near Poncha Pass, 8750 ft., 2 (WC). TELLER COUNTY: Florissant, 2 (WC); Divide, 9200 ft., 1 (WC); west slope Pikes Peak, 10,000 ft., 3 (USNM). EL PASO COUNTY: Cascade, 7500 ft., 1 (USNM); *Pikes Peak,* 1 (USNM); *Colorado City,* 3 (MCZ). MONTROSE COUNTY: 5 mi. W Olathe, 1 (CSU); Montrose, 2 (DMNH). OURAY COUNTY: Ridgway, 2 (1 SC, 1 WC). SAGUACHE COUNTY: 7 mi. N Villa Grove, 1 (CSU); 26 mi. SE Gunnison, 2 (CSU); *Saguache Park,* 2 (1 CSU, 1 USNM); *1 mi. N Saguache,* 2 (USNM); Cochetopa Pass, 33 mi. W Saguache, 10,000 ft., 1 (KU); *Tevebaugh's Ranch, 20 mi. W Saguache,* 27 (USNM); 16 mi. W Saguache, 1 (KU); *3 mi. W Saguache,* 1 (CSU); Saguache, 6 (5 DMNH, 1 USNM). FREMONT COUNTY: 30 mi. E Salida, 1 (CU); *no locality other than county,* 4 (FMNH). CUSTER COUNTY: *Querida,* 2 (WC); 4 mi. NE Rosita, 1 (CSU). HINSDALE COUNTY: head of Rio Grande, 1 (AMNH). MINERAL COUNTY: Wagon Wheel Gap, 13 (3 AMNH, 1 MCZ, 9 WC). ALAMOSA COUNTY: Great Sand Dunes National Monument, 1 (GSDNM). HUERFANO COUNTY: 1/2 mi. E Farisita, 2 (CSU); La Veta Pass, 9100 ft., 4 (USNM); 4 mi. S La Veta, 7100 ft., 1 (KU). CONEJOS COUNTY: 12 mi. NE Cumbres, 8800 ft., 1 (AMNH); Antonito, 2 (USNM); Osier, 2 (DMNH). COSTILLA COUNTY: 15 mi. N Trinchera Peak, 1 (AMNH); *10 mi. N Trinchera Peak,* 1 (AMNH); 4 mi. N, 6 mi. W Blanca, 2 (KU); *near Blanca,* 1 (CSU); Fort Garland, 19 (1 UMMZ, 18 USNM); 10 mi. E Fort Garland, 1 (CSU); *Fort Massachusetts,* 1 (USNM); *7 mi. N Trinchera Peak,* 1 (AMNH); 2 1/2 mi. S San Acacio, 1 (CSU).

Additional records (Burnett, 1913:6, unless otherwise noted): JEFFERSON COUNTY: *Deckers* (Lechleitner, 1969:93). PARK COUNTY: *Como* (Cary, 1911:95); Tarryall River, Pike National Forest (Silver, 1928:63); *4 1/2 mi. SW Fairplay* (Ecke and Johnson, 1950:192); *Montgomery* (Blake and Blake, 1969:36); 13 mi. SE Hartsel (Ecke and Johnson, *loc. cit.*); *Guffey; Castrel's Ranch* (not found) (Hollister, 1916:29). GUNNISON COUNTY: near Crested Butte (Warren, 1908b:71); Black Mesa (Cary, 1911: 95); *1/2 mi. E Eagle Rock, 7560 ft.* (Durrant and Robinson, 1962:248); *1 mi. W Steuben Creek on Gunnison River, 7460 ft.* (Durrant and Robinson, *loc. cit.*). CHAFFEE COUNTY: *Centerville [near Nathrop].* TELLER COUNTY: Woodland Park. MONTROSE COUNTY: Cerro Ridge (Cary, 1911: 95). SAGUACHE COUNTY: Bowers Peak, 12,000 ft. (as Mineral County in Lechleitner, 1969:93). FREMONT COUNTY (Burnett, 1915:8, unless otherwise noted): Howard; Texas Creek (Cary, 1911:96); Micanite [Malachite?]; *Whitehorse* (not found). CUSTER COUNTY: Greenwood; *Westcliffe.* RIO GRANDE COUNTY: South Fork (Hollister, 1916: 29). HUERFANO COUNTY: Badito (Cary, 1911: 96). CONEJOS COUNTY: Capulin; *La Jara.* COSTILLA COUNTY: Mesita. LAS ANIMAS COUNTY: ". . . parks and plateaus of the Trinidad region" (Cary, 1911:96).

Cynomys gunnisoni zuniensis Hollister

Cynomys gunnisoni zuniensis Hollister, N. Amer. Fauna, 40:32, 20 June 1916; type locality, Wingate, McKinley Co., New Mexico.

Distribution in Colorado.— Southwestern part of state, south of Uncompahgre Plateau and San Juan mountains (Fig. 50).

Comparison.—For comparison with *C. g. gunnisoni,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of four females, all from Montezuma County, are: 367.0 (350-374), 348.8 (335-

365); 67.0 (60-78), 62.8 (60-65); 56.8 (56-59), 53.8 (52-55). For cranial measurements, see table 12.

Remarks.—Durrant and Dean (1961:167) considered a specimen from river-mile 172, San Juan River, Archuleta County, to be an intergrade between *C. g. zuniensis* and *C. g. gunnisoni,* but referable to the former subspecies. I have examined no specimen from southwestern Colorado that I would consider an intergrade between those two subspecies.

Records of occurrence.—Specimens examined, 67, distributed as follows: MONTROSE COUNTY: 5 mi. W Uravan, 3 (CSU); Bedrock, 3 (2 CSU, 1 WC); *5 mi. W Nucla,* 2 (CSU); Nucla, 1 (DMNH); Coventry, 2 (WC). SAN MIGUEL COUNTY: *1 1/2 mi. N Norwood,* 1 (CSU); Norwood, 10 (3 CSU, 6 SC, 1 WC); Lone Cone Peak, 1 (SC). MONTEZUMA COUNTY: Lewis, 1 (FWS); head of McElmo Canyon, 1 (DMNH); *McElmo Canyon,* 1 (CSU); *W of Cortez,* 3 (CSU); Cortez, 10 (1 AMNH, 9 USNM); *E of Cortez,* 1 (CSU); *1 mi. E Cortez,* 1 (CSU); *1 1/2 mi. E Cortez,* 1 (CSU); Mancos, 4 (SC); Ute Peak, 11 (4 AMNH, 7 DMNH); Four Corners, 3 (2 AMNH, 1 DMNH). LA PLATA COUNTY: Bondad, 2 (DMNH). ARCHULETA COUNTY: Chromo, 2 (DMNH); 5 mi. NW Chama, New Mexico, 2 (DMNH); NW 1/4, sec. 23, T. 32 N, R. 6 W, 2 (UNM).

Additional records (Burnett, 1915:8, unless otherwise noted): MONTROSE COUNTY: Naturita (Burnett, 1913:6); Redvale (Aldous, 1935:130). MONTEZUMA COUNTY: Dolores (Burnett, 1913:6); *near Dolores* (Young, 1944a:317); *Lebanon; Arriola;* Prater Canyon, 7600 ft., Mesa Verde National Park (Anderson, 1961:42). LA PLATA COUNTY: Vallecito (Cary, 1911:96); Hermosa; Hesperus; *Fort Lewis Mesa;* Bayfield (Cary, *loc. cit.*); Tiffany. ARCHULETA COUNTY: (Durrant and Dean, 1961:167): *across San Juan River from mouth of Piedra River;* river-mile 172, San Juan River. County unknown: *Dolores Pass, 10,000 ft.* (Aldous, 1935:130).

Sciurus aberti

ABERT'S SQUIRREL

Sciurus aberti is distributed in Colorado in the foothills and lower mountains of the Eastern Slope and in the San Juan Mountains. The northernmost record of the species is from immediately north of the Colorado boundary at a place 1/4 mi. E Harriman, Laramie Co., Wyoming (L. N. Brown, 1965). Extremes of altitudinal range of specimens examined are Loveland (probably the wooded foothills west of that city) and Cañon City, about 5300 feet, up to more than 10,200 feet at Montezuma, Summit County. That the latter specimen was taken at Montezuma is perhaps open to doubt. Abert's squirrel is rather closely confined to forests of *Pinus ponderosa;* this relationship was detailed by Keith (1965). Wade (1935) reported casual observations on activities of Abert's squirrel in the Front Range. Rice (1957) reported observations of sexual behavior, and the baculum was described by Wade and Gilbert (1940).

Local distribution of this species is spotty and populations tend to fluctuate markedly over time. The so-called "Black Forest" on the Platte-Arkansas Divide in Douglas and El Paso counties has been a center of relatively high populations in recent years; in the southwestern part of the state, the vicinity of Pagosa Springs is such an area. Because of its uncertain status over much of its range in Colorado, *S. aberti* has been given the explicit protection of state law.

Sciurus aberti ferreus True

Sciurus aberti concolor True, Diagnoses of new North American mammals, p. 1, 26 April 1894 (preprint of Proc. U. S. Nat. Mus., 17:241, 15 November 1894); type locality, Loveland, Larimer Co., Colorado (probably the wooded foothills west of that city). Not *Sciurus concolor* Blyth, 1855.

[Sciurus aberti] ferreus True, Proc. Biol. Soc. Washington, 13: 183, 30 November 1900 (a renaming of *S. a. concolor* True).

Distribution in Colorado.—Foothills and lower mountains of Eastern Slope, extending eastward on Platte-Arkansas Divide at least to Elbert County; Sangre de Cristo Range (Fig. 51).

Comparison.—From *S. a. mimus,* the subspecies of the San Juan Mountains, *S. a. ferreus* differs principally in much less extensive reddish patch on the dorsum and the presence in the population of three color phases (see remarks).

Measurements.—External measurements of a male and female from the vicinity of Estes Park are: 572, 523; 292, 240; 70, 71; 37, 45; the male weighed 681. Selected cranial measurements of the holotype (USNM 36281, a young adult female) and two additional females from Larimer County are, respectively: greatest length of skull, 57.8, 60.2, 60.4; condylobasal length, 52.0, 56.2, 55.9; zygomatic breadth, 34.3, 35.9, 35.9; interorbital breadth, 18.7, 19.4, 21.1; postorbital breadth, 18.3, 18.0,

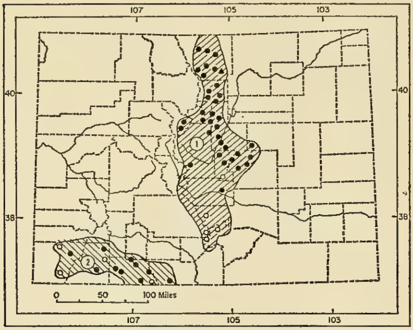


FIG. 51. Distribution of *Sciurus aberti* in Colorado. 1. *S. a. ferreus*. 2. *S. a. mimus*. For explanation of symbols, see p. 9.

18.4; length of nasals, 19.4, 18.0, 18.4; mastoid breadth, 24.4, 25.6, 25.5; length of maxillary toothrow, 11.0, 11.0, 11.1.

Remarks.—Sciurus a. ferreus occurs in three color phases. The holotype is gray, but black and brown individuals are common. Some individuals appear to be exceptionally dark brown, which seems to be the typical color of squirrels of the black phase when the pelage is worn. Certain specimens (KU 27461, CU 4783, 5151) illustrate molt from the dark brown to typical black pelage. Individuals of the brown phase vary from a dark chocolate brown through tan, although the color of the palest specimens may result from "foxing" of skins with age. Of 118 skins examined from Colorado, 44 were gray, 61 black or dark brown, and 13 some other shade of brown. Of 43 skins examined from Larimer County, 22 were black and 21 were gray, but none was brown. Among 20 specimens from the Rampart Range and the Platte-Arkansas Divide, only two were gray; 10 were black and eight were pale brownish. Evidently the proportions have not remained constant over time. Warren (1942:153) stated that "in the mountains near Colorado Springs there are grays and blacks but no browns." Brown individuals apparently are unknown in other subspecies of this squirrel, but partial and complete melanism was noted by V. Bailey (1932:69) in *S. a. aberti*. Ramey and Nash (1971) presented brief notes on the distribution of Abert's squirrel in Colorado.

The subspecies of *S. aberti* have been distinguished principally on the basis of color and are in need of revision. Specimens are lacking from the Sangre de Cristo Range in Colorado; when this area is better known it may prove to be an area of intergradation between *S. a. ferreus* and *S. a. mimus*. The main center of abundance of *ferreus* in the Front and Rampart ranges is separated from the San Juan Mountains, the range of *mimus* in Colorado, by the San Luis Valley.

Records of occurence.—Specimens examined, 133, distributed as follows: LARIMER COUNTY: 40 mi. [by road] up Poudre Canyon, 1 (CSU); 5 mi. N Stove Prairie School, 1 (CSU); *16 mi. NW Fort Collins*, 1 (CSU); *10 mi. NW Fort Collins*, 1 (CSU); Bellvue, 1 (USNM); *25 mi. [by road] W Fort Collins, 7500 ft.*, 1 (CSU); Glen Haven, 1 (RMNP); *3 mi. NW Arkins, about 7000 ft.*, 2 (USNM); Arkins, 11 (USNM); *[near] Loveland, 7000 ft.*, 2 (USNM); Loveland, 1 (USNM); Horseshoe Park, 1 (RMNP); *1 mi. inside Fall River Entrance, Rocky Mountain National Park*, 1 (RMNP); *Fall River Entrance*, 1 (RMNP); *2 mi. NE Estes Park*, 1 (CSC); *4 mi. W Estes Park*, 1 (CU); *Estes Park*, 7 (1 AMNH, 1 CSU, 1 CU, 2 DMNH, 1 RMNP, 1 USNM); *S of Estes Park*, 1 (CU); *1 mi. inside Beaver Meadows Entrance*, 1 (RMNP); *2 mi. W Beaver Meadows Entrance*, 1 (RMNP); *1 mi. S, 1/2 mi. W Estes Park*, 1 (KU); *1 1/2 mi. W Beaver Meadows intersection*, 1 (RMNP); *Beaver Meadows*, 2 (RMNP); *2 1/2 mi. SW Estes Park*, 2 (KU); *1/2 mi. S Beaver Point, Mary's Lake Road*, 1 (RMNP); *between Beaver Meadows Entrance and Moraine Park*, 1 (RMNP); *Mill Creek Ranger Station*, 1 (RMNP); *Big Thompson River Entrance*, 1 (RMNP); Bear Lake Road, 1 (RMNP); *Rocky Mountain National Park*, 4 (1 CSU, 3 RMNP); *no locality other than county*, 1 (CSU). SUMMIT COUNTY: Montezuma, 1 (DMNH); Breckenridge, 1 (DMNH). BOULDER COUNTY: *1 1/10 mi. W Lyons*, 1 (CU); Lyons, 2 (FMNH); *2 mi. up Lefthand Canyon*, 1 (CU); 4 mi. ESE Ward, 1 (CU); 1 mi. SW Sugarloaf Mountain, 1 (CU); *Boulder Canyon*, 1 (CU); *3 mi. W Boulder*, 1 (CU); *1 mi. W Boulder*, 1 (CU); Boulder, 1 (CU); Magnolia Road, about 8 mi. SW Boulder, 1 (KU). CLEAR CREEK COUNTY: Idaho Springs, 1 (DMNH); Evans Ranch, Brookvale, 4 (DMNH); 9 mi. S Idaho Springs, 1 (WC). JEFFERSON COUNTY: *Genesse Park*, 1 (DMNH); Bergen Park, 1 (DMNH); *U. S. Highway 40, near Tepees*, 1 (CU); *mountains W of Denver*, 1 (USNM); *10 mi. W Evergreen*, 3 (WC); Evergreen, 5 (3 CU, 2 DMNH); *2 mi. E Conifer*, 2 (CSC); *3 mi. SW Conifer*, 1 (UI); *Denver Mountain Park*, 2 (DMNH); *Buffalo [Creek]*, 1 (AMNH); *2 mi. S Evergreen*, 1 (CSU); *2 mi. NW Tiny Town*, 1 (UI); *4 mi. S Evergreen*, 1 (CSU); Dome Rock [T. 7 S, R. 70 W], 1 (AMNH); *no locality other than county,* 4 (3 DMNH, 1 USNM). PARK COUNTY: *Craig Creek, near Bailey, 8000 ft.,* 1 (USNM); Bailey, 4 (FWS); 1/2 mi. E Trout Creek Pass, near Antero Junction, 1 (CU). DOUGLAS COUNTY: Deckers, 2 (DMNH); 39 mi. S, 5 mi. W Denver, 1 (CSU). ELBERT COUNTY: Elbert, 1 (CU); *S of Elbert,* 2 (DMNH). TELLER COUNTY: 13 mi. N Florissant, 8900 ft., 1 (FWS); Manitou Experimental Forest, 1 (CSU); *4 mi. N Woodland Park, 8500 ft.,* 1 (SCSC). EL PASO COUNTY: 3 mi. E Monument, 1 (CU); 3 mi. SW Eastonville, 5 (USNM); U. S. Air Force Academy, 1 (CSU); 3 mi. N Falcon, 2 (UMMZ); Colorado Springs, 3 (USNM); *Colorado City,* 1 (USNM); *Bear Creek Canyon,* 1 (WC); *Cheyenne Mountain,* 1 (CU); *no locality other than county,* 2 (1 UI, 1 WSC). FREMONT COUNTY: Cañon City, 1 (DMNH).

Additional records (Cary, 1911:66, unless otherwise noted): LARIMER COUNTY: *12 mi. W Loveland.* BOULDER COUNTY: *South St. Vrain Canyon* (Wade, 1935:201); *Gold Hill; 14 mi. SW Boulder.* JEFFERSON COUNTY: *Genesse Mountain* (Rice, 1957:129). CHAFFEE COUNTY: "I have heard of it near Salida but it is very rare there" (Warren, 1942:153). TELLER COUNTY: *14 mi. NW Woodland Park* (Warren, *loc. cit.*); Cripple Creek. EL PASO COUNTY: *Cascade.* SAGUACHE COUNTY: lower portions of Medano and Mosca passes (Warren, 1942:153). CUSTER COUNTY: ". . . eastern slope of Sangre de Cristos . . . as far north as Westcliffe" (Warren, *loc. cit.*). HUERFANO COUNTY: around Bradford.

Sciurus aberti mimus Merriam

Sciurus aberti mimus Merriam, Proc. Biol. Soc. Washington, 17:130, 9 June 1904; type locality, Hall Peak, S end Cimarron Mountains, Mora Co., New Mexico.

Distribution in Colorado.—Wooded foothills, mesas, and lower mountains of southwestern part of state (Fig. 51).

Comparison.—For comparison with *S. a. ferreus,* see account of subspecies.

Measurements.—External measurements of the holotype (USNM 70908, young adult female) are: 485, 215, 70. Selected cranial measurements of the holotype, followed by those of a male and two females from Pagosa Springs, are, respectively: greatest length of skull, 55.7, 60.3, 60.0, 59.8; condylobasal length, 51.2, 56.0, 55.5, 55.2; zygomatic breadth, 33.3, 35.1, 36.3, 36.2; interorbital breadth, 18.5, 19.9, 19.0, 19.5; postorbital breadth, 18.8, 19.4, 18.5, 18.4; length of nasals, 18.8, 19.9, 20.8, 20.3; mastoid breadth, 23.5, 25.0, 25.5, 25.2; length of maxillary toothrow, 11.2, 11.2, 11.7, 11.4.

Remarks.—The extent of the reddish middorsal patch, a principal character in distinguishing *S. a. mimus* from *S. a. aberti,* evidently varies individually and with changes in the pelage. A specimen from Florida, La Plata County (AMNH 5231), has no patch, nor does one from Pagosa Springs (USNM 149023). Another specimen from Pagosa Springs (USNM 149026), obtained on 29 May, has a sharp molt line, a pale reddish patch on the worn winter pelage, and a well-developed patch in the new summer pelage.

Intergradation between *S. a. mimus* and *S. a. ferreus* in Colorado has not been demonstrated.

Coues and Yarrow (1875:115) noted that "one specimen [of *S. aberti*] was taken in Northwestern Colorado, which is probably its northern limit." I am unaware of any specimen from northwestern Colorado to which those authors might have referred. They listed a specimen from Tierra Amarilla, a land grant in what is now southeastern Archuleta County, east of the Navajo River. Perhaps their reference is to that individual. There are no records of *S. aberti* from western Colorado north of the San Juan Mountains, nor are such records to be expected, for ponderosa pine occurs north of the San Juans only in small, disjunct stands.

Records of occurrence.—Specimens examined, 35, distributed as follows: MONTEZUMA COUNTY: Menegee [Menefe] Switch, 5 mi. N Mancos, 1 (SC); *Menegee [Menefe],* 1 (DMNH). LA PLATA COUNTY: 21 mi. N Bayfield, 1 (AMNH); *10 mi. E Durango,* 1 (ASC); Florida, 1 (AMNH); *East Animas* (not found), 1 (WSC). ARCHULETA COUNTY: 5 mi. NW Pagosa Springs, 3 (WC); Pagosa Springs, 6 (USNM); Upper Navajo River, 2 (DMNH); 17 mi. E Bayfield, 1 (AMNH); Dyke, 12 (DMNH); Navajo River, 5 (DMNH).

Additional records (Cary, 1911:67, unless otherwise noted): MONTEZUMA COUNTY: Dolores Plateau, NE of Dolores; near Park Well, Mesa Verde National Park (Anderson, 1961:40). LA PLATA COUNTY: upper valley of the Los Piños; *along Vallecito Creek.* ARCHULETA COUNTY: Tierra Amarilla (Coues and Yarrow, 1875:115). CONEJOS COUNTY: 10 mi. W Antonito.

Sciurus niger

Fox Squirrel

Cary (1911:64) noted that "fox squirrels are not indigenous to Colorado, but have been introduced at Greeley, where they are increasing in a gratifying manner. . . ." Young (1908:406) noted that the squirrels also occurred at Denver, and Warren (1942:308) reported the presence of a few fox squirrels at Colorado Springs. During the 1920's, the species was introduced at Sterling and at Fort Collins (Lechleitner, 1969:108). Evidently they also have been introduced at Limon.

The population in the South Platte Valley is well established. Suitable habitat there is restricted, however, to the river bottom community, dominated by *Populus sargentii,* and to artificial habitat in towns or in hedgerows along ditch-banks. In recent years, the introduced population probably has been reinforced by natural invasion from the east (Hoover and Yeager, 1953). This has been allowed by the relative stability of the riparian woodland over the past half-century. It is on the strength of the possibility of such a natural invasion that *Sciurus niger* is included as a member of the native fauna of Colorado. In the distribution map for this species (Fig. 52), only the conterminous range in the South Platte and Republican watersheds is shaded. Extra-limital localities are plotted, however.

The status of *S. niger* in Colorado was detailed by Hoover and Yeager (1953). Yeager (1959) discussed the ecology of the species in Colorado and suggested that the outlook for fox squirrels in the state was unfavorable. The cottonwood stands to which the animals are mostly restricted are being reduced at present. Many of the stands are overmature, and natural reproduction is held back by grazing of livestock in bottomlands and by fire. Cottonwoods frequently are removed from irrigated lands because of their high rate of water consumption. As cottonwood stands are reduced, so also are requisite conditions for a viable population of fox squirrels.

The fox squirrel has invaded the foothills to some extent in the deciduous vegetation of streamside communities. The animals are abundant in the lower Rist Canyon, west of Bellvue, for example, and also occur along the larger streams, such as the Big Thompson River and Boulder Creek. The extreme of utilization of such habitat was reported by Hoover and Yeager (1953:360). One specimen was obtained some 20 miles west of Fort Collins along Buckhorn Creek at an elevation of about 7800 feet.

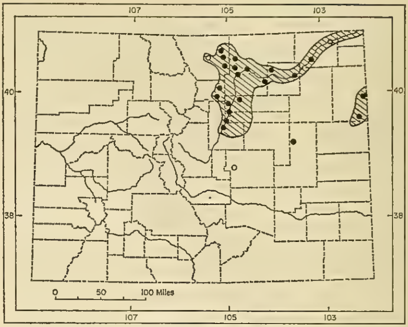


FIG. 52. Distribution of *Sciurus niger rufiventer* in Colorado. Shaded area is conterminous range in state; isolated symbols represent extralimital introductions (see text for discussion). For explanation of symbols, see p. 9.

Hoover (1954) reported on litter-size in Coloradan fox squirrels. Borrell (1961) noted a casual observation of antagonistic behavior of a fox squirrel toward a mourning dove in Denver.

In 1968 the fox squirrel was accorded the status of a game animal in Colorado, and a three-month open season was established. Unpublished data from the Division of Game, Fish and Parks indicate a harvest of 5067 animals by 1699 hunters during the first hunting season.

Sciurus niger rufiventer É. Geoffroy St.-Hilaire

Sciurus rufiventer É. Geoffroy St.-Hilaire, Catalogue des mammifères du Museum National d'Histoire Naturelle, Paris, p. 176, 1803; type locality, Mississippi Valley, probably between southern Illinois and central Tennessee (see Osgood, 1907).

Sciurus niger rufiventer, Osgood, Proc. Biol. Soc. Washington, 20:44, 18 April 1907.

Distribution in Colorado.—Primarily in riparian woodlands of South Platte and Republican drainages; introduced elsewhere (see Fig. 52 and Hoover and Yeager, 1953:360).

Measurements.—Mean (and extreme) external measurements of eight males, followed by those of 10 females, from Larimer and Weld counties, are: 502.0 (462-576), 500.2 (470-537); 222.1 (172-244), 232.8 (196-293);

66.0 (60-69), 63.4 (50-73); 26.2 (19-33), 25.2 (20-31); weight, 745.4 (541-1065), 599.5 (418-781). Average (and extreme) cranial measurements of eight males, followed by those of 16 females, all from Larimer and Weld counties, are: greatest length of skull, 62.78 (61.1-65.5), 61.76 (59.5-65.5); condylobasal length, 58.26 (57.1-60.5), 57.22 (53.6-60.7); zygomatic breadth, 35.31 (34.3-36.4), 35.34 (33.6-37.2); postorbital breadth, 19.22 (18.8-20.0), 19.13 (17.5-20.7); length of nasals, 21.68 (21.1-22.2), 21.14 (18.6-23.5); length of maxillary toothrow, 11.13 (10.7-11.5), 10.98 (10.3-11.8).

Remarks. — According to Young (1908: 406) fox squirrels introduced at Greeley were brought from Omaha. A specimen (KU 9172) obtained in August 1931 at Denver bears the notation "introduced from Oklahoma." The source of other adventive stocks is not known. Squirrels that I have examined from Colorado are within the range of variation of fox squirrels from eastern Kansas and are herein referred provisionally to the subspecies *S. n. rufiventer.*

The Coloradan population seems to have a high incidence of pale buff to nearly white underparts. The dorsal color of most specimens is typically less bright than those from farther west on the Great Plains. Possibly this is a result of the drier, more rarefied atmosphere of northeastern Colorado.

Records of occurrence.—Specimens examined, 123, distributed as follows: LARIMER COUNTY: 7 mi. N, 1/4 mi. W Fort Collins, 1 (CSU); *6 mi. NW Fort Collins,* 1 (CSU); *4 mi. N, 4 mi. E Fort Collins,* 1 (CSU); *3 mi. N, 6 mi. W Fort Collins,* 1 (CSU); *1/2 mi. SE Laporte,* 1 (CSU); *1/2 mi. SE Bellvue,* 1 (CSU); *1 mi. NW Fort Collins,* 1 (CSU); *1/4 mi. N Fort Collins,* 1 (CSU); *1 mi. W Fort Collins,* 2 (CSU); Fort Collins, 16 (15 CSU, 1 USNM); *1/8 mi. S, 1 mi. W Fort Collins,* 1 (CSU); *1/2 mi. S, 1/4 mi. W Fort Collins,* 1 (CSU); *1 mi. S, 1/2 mi. W Fort Collins,* 1 (CSU); *1 mi. W Interstate 25 on Timnath Road,* 1 (CSU); *Harmony,* 2 (CSU); *3 mi. S, 2 mi. E Fort Collins,* 1 (CSU); *E 1/2 sec. 20, T. 7 N, R. 68 W,* 1 (CSU); *3 mi. S, 6 mi. E Fort Collins,* 1 (CSU); *4 mi. S, 2 mi. E Fort Collins,* 1 (CSU); 5 mi. S, 2 mi. E Fort Collins, 1 (CSU). WELD COUNTY: 9 mi. E Fort Collins, 1 (CSU); *3 mi. S, 7 mi. E Fort Collins,* 1 (CSU); *1 3/4 mi. N, 1 1/2 mi. W Windsor,* 1 (CSU); *2 mi. W Windsor,* 1 (CSU); *1 1/2 mi. W Windsor,* 1 (CSU); 1 mi. W Windsor, 5 (CSU); *1 mi. E Windsor,* 2 (CSU); *6 mi. W Greeley,* 1 (CSC); Greeley, 2 (DMNH); *3 mi. E Greeley,* 3 (CSU); *5 mi. E Greeley,* 1 (CSC); *6 mi. E Greeley,* 1 (CSC); *South Platte River, S of Greeley,* 1 (CSC); *2 mi. W Evans,* 1 (CSC); 2 mi. S, 5 mi. W Evans, 1 (CSC); *7 mi. S, 4 mi. W Greeley,* 1 (CSC); *1 mi. N Milliken,* 1 (CSC); Empire Reservoir, 2 (DMNH). MORGAN COUNTY: Jackson Reservoir, 9 (DMNH); *1 mi. N, 2 mi. W Weldona, 4600 ft.,* 1 (CSU); *Orchard,* 1 (DMNH); South Platte River, N of Brush, 1 (CU); *5 mi. E Fort Morgan,* 1 (CSU). LOGAN COUNTY: sec. 17, T. 6 N, R. 53 W, 1 (CSU). BOULDER COUNTY: 4 mi. S, 5 mi. W Longmont, 1 (CSU); *1/2 mi. S, 3 mi. E Boulder,* 1 (CSU); *Boulder,* 16 (CU); Boulder Canyon, 1 (CU); *Flatirons,* 1 (CU). ADAMS COUNTY: Barr Lake, 2 (DMNH); NE 1/4 sec. 7, T. 3 S, R. 68 W, 1 (CSU). DENVER COUNTY: Denver, 16 (2 CSU, 14 DMNH). ARAPAHOE COUNTY: South Platte River, 1 (DMNH). YUMA COUNTY: 20 mi. SE Wray, 2 (CSU); W end Bonny Reservoir, 1 (CU). DOUGLAS COUNTY: South Platte River, 1 (DMNH). LINCOLN COUNTY: Limon, 1 (DMNH).

Additional records (Hoover and Yeager, 1953: 360, unless otherwise noted): LARIMER COUNTY: Buckhorn Creek, about 20 mi. W Fort Collins, *ca.* 7800 ft. LOGAN COUNTY: near Crook; Sterling. EL PASO COUNTY: Colorado Springs (Warren, 1942:308).

Tamiasciurus hudsonicus

CHICKAREE

The chickaree, or "pine squirrel," ranges throughout the denser forests of the mountains and higher plateaus and mesas of Colorado, where it may be abundant locally. Extremes of altitudinal range of specimens examined are 6000 feet in Montrose County and 12,000 feet in Lake County. In general only dense stands of lodgepole pine, Douglas-fir, spruces, and firs support large populations, but occasional individuals are found both above and below these forest zones. In North Crestone Canyon, Saguache County, I have observed chickarees in cottonwoods and leaping among boulders in mine dumps. In the Front Range, *Tamiasciurus hudsonicus* is most abundant in stands of lodgepole pine, immature stands of which may present a nearly impenetrable maze. Such stands are an early stage in succession following fire and are themselves readily susceptible to fire. Hatt (1943) detailed the relationship of chickarees to fire as part of an extensive report on the natural history of the species in the Front Range.

The occurrence of chickarees in an area is immediately revealed by their unmistakable chattering and the presence of middens of cone-scales and other debris. Such middens may be extensive; Warren (1932c) described one in northwestern Gunnison County that was 33 feet in length and 3 to 4 feet wide. Cone caches are such obvious features of the dense coniferous forest that foresters have long debated the influence of chickarees on natural forestation. Caches are exploited by man as the principal commercial source of seeds of conifers. For an excellent study of provisioning behavior and the economic importance of *T. hudsonicus* in Colorado, see Finley (1969).

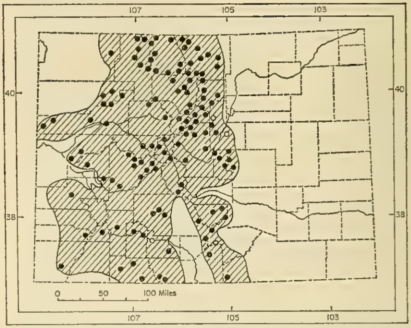


FIG. 53. Distribution of *Tamiasciurus hudsonicus fremonti* in Colorado. For explanation of symbols, see p. 9.

Tamiasciurus hudsonicus fremonti (Audubon and Bachman)

Sciurus fremonti Audubon and Bachman, The viviparous quadrupeds of North America, 3:237 and pl. 149, fig. 2, 1853; type locality, probably the park region of central Colorado (see remarks below).

T[amiasciurus]. hudsonicus fremonti, Hardy, Proc. Biol. Soc. Washington, 63:14, 26 April 1950.

Distribution in Colorado.—Mountains, higher plateaus and mesas of western three-fifths of state (Fig. 53).

Comparisons.—From *T. h. baileyi*, the subspecies of central and southern Wyoming, *T. h. fremonti* differs in smaller external and cranial size and markedly darker color (less suffused with reddish). From *T. h. mogollonensis*, the subspecies of northern New Mexico, *T. h. fremonti* differs in slightly smaller size, less reddish upper parts, and less extensive black on the terminal portion of the tail.

Measurements.—Mean (and extreme) external measurements of 13 males, followed by those of 12 females, all from the Sawatch Range of Lake and Chaffee counties, are: 320.0 (302-343), 319.9 (300-352); 125.2 (116-135), 124.1 (117-132); 49.2 (46-51), 48.9 (46-52); 24.6 (19-27), 25.3 (21-29); mean weight of 11 males, 227.77 (202.5-252.0), of seven females, 222.73 (193.7-238.6). Selected cranial measurements of 13 males and 12 females from the Sawatch Range are: greatest length of skull, 47.09 (46.0-48.1), 46.93 (46.1-47.8); condylobasal length, 44.05 (42.9-45.4), 43.52 (42.4-44.7); interorbital breadth, 14.94 (14.4-15.6), 14.67 (14.3-15.0); postorbital breadth, 14.93 (14.2-15.9), 14.82 (14.2-15.7); length of nasals, 15.29 (14.1-16.1), 15.48 (14.4-16.2); length of maxillary toothrow, 8.25 (7.6-8.8), 8.31 (7.8-8.8).

Remarks. — *Tamiasciurus hudsonicus* is widespread in North America, occupying nearly half of the continent north of México. The species varies markedly over this range, in color, size, and cranial details. This geographic variation is in need of modern, definitive study.

The type locality of *T. h. fremonti* is not known with certainty. Audubon and Bachman (1856, 3:238) noted that the only specimen they had examined was obtained by John C. Fremont and was ". . . procured on the Rocky Mountains, on his route by the south pass to California." Baird (1858:272) stated: "The specimen described by Audubon and Bachman was collected in 1849 by Colonel Fremont somewhere in the vicinity of South Pass and is now in the Museum of the Philadelphia Academy of Sciences. The one brought home by Captain Beckwith was found in the Sawatch Pass, and the two are all that as yet have come to the notice of naturalists." The description by Baird obviously is of *T. h. fremonti*, as currently understood, and not of *T. h. ventorum*, the subspecies of the Wind River Mountains (South Pass is located at the southern terminus of the Wind Rivers, and is at the southern margin of the known distribution of *ventorum*). Baird (*loc. cit.*) identified the type specimen of *fremonti* with Beckwith's specimen from Saguache Pass.

J. A. Allen (1898:289) examined the holotype and judged it to be representative of *T. hudsonicus* of the mountains of Colorado. Based on the condition of the pelage, the specimen was supposed to have been taken in spring, and reference to Fremont's reports led Allen to conclude that the squirrel upon which the description of *fremonti* was based was obtained between 11 and 26 June 1844, somewhere between the North Fork of the North Platte and the headwaters of the Arkansas River.

Intergradation in extreme southern Colorado between *T. h. fremonti* and *T. h. mogollonensis* is to be expected, but has not been conclusively demonstrated. The color of Coloradan chickarees is highly variable, but most specimens from the central part of the state show little or no reddish wash on the dorsum. Specimens from the southern part of the state show a general tendency toward a reddish suffusion of the upper parts, suggesting a trend toward *T. h. mogollonensis* (as known to me by specimens from northern New Mexico). This is particularly true of material from the Navajo River drainage of eastern Archuleta County. Bailey (1932:75) indicated that a specimen from Chama, Rio Arriba Co., New Mexico, might be an intergrade between the two subspecies in question. Variation in Coloradan chickarees over their range in the state is no greater than that seen in specimens from the Sawatch Range, and I do not hesitate to refer all material that I have examined to a single subspecies. Findley (1961) discussed patterns of geographic variation in chickarees in New Mexico in some detail.

Chickarees from the Laramie Mountains of southeastern Wyoming were referred by Long (1965:594) to the subspecies *T. h. baileyi*. That author saw no evidence of intergradation between *baileyi* and *fremonti* in Wyoming, and I have seen no obviously intermediate specimens from Colorado, although specimens from Homestead Ranch, Jackson County, have a prominent mid-dorsal reddish patch. South of Pole Mountain, suitable habitat for chickarees in the Laramie Range of Wyoming is minimal and the population of *baileyi* to the north may be sufficiently isolated from *fremonti* in Colorado to preclude intergradation.

Records of occurrence.—Specimens examined, 506, distributed as follows: MOFFAT COUNTY: 16 mi. N Craig, 6600 ft., 1 (KU). ROUTT COUNTY: Park Range, 20 mi. N Hahn's Peak, 9000 ft., 1 (USNM); *Dome Peak,* 3 (DMNH); *Elkhead Mountains, 20 mi. SE Slater,* 1 (USNM); Hahn's Peak, 1 (USNM); *30 mi. N Steamboat Springs, 8400 ft.,* 1 (CSU); Mystic, 1 (DMNH); Steamboat Springs, 1 (DMNH); Rabbit Ears Pass, 9680 ft., 3 (2 CM, 1 CSU). JACKSON COUNTY: Pearl, 9000 ft., 1 (USNM); 30 mi. NW Cowdry, 1 (CSU); 2 mi. W Kings Canyon, 1 (CSU); 15 mi. SW Pearl, 1 (CSU); *Zirkel Dome Wilderness Area,* 1 (CU); near Hell Creek, 1 (WC); Buffalo Pass Road, 10,000 ft., 1 (WC); 1/4 mi. S Gould, 9000 ft., 2 (CU); *Rabbit Ears Pass,* 2 (CSU); Arapaho Pass, 3 (USNM); *Homestead Ranch,* 14 (DMNH); 5 mi. SE Rand, 1 (CSU); *Jack Creek Ranch Quadrangle,* 1 (CSU); Red Cañon, 1 (WC). LARIMER COUNTY: 9 mi. SW Woods Landing, Wyoming, 8300 ft., 2 (CSU); *11 mi. N Red Feather Lakes, 9000 ft.,* 1 (CSU); *2 mi. N Sand Creek Pass, 9200 ft.,* 1 (CSU); Bull Mountain, sec. 17, T. 11 N, R. 75 W, 10,000 ft., 1 (CU); *43 mi. NW Fort Collins,* 1 (CSU); *9 mi. NE Glendevy, 8700 ft.,* 1 (CSU); *36 mi. NW Fort Collins,* 2 (CSU); *Medicine Bow Range,* 2 (DMNH); *2 mi. E Glendevy,* 1 (CU); *10 mi. W Red Feather Lakes,* 2 (1 CSU, 1 CU); *8 mi. W Red Feather Lakes,* 1 (CSU); *North Lone Pine Creek, 3 mi. W Red Feather Lakes,* 3 (1 CU, 2 USNM); *[below] Deadman Pass, 3 mi. W Red Feather Lakes,* 1 (CSU); *2 mi. W Red Feather Lakes,* 2 (CU); Glendevy Ranch, 8500 ft., 1 (USNM); *SW 1/4 sec. 30, T. 10 N, R. 73 W,* 1 (CU); Parvin Lake, 1 (CU); *2 mi. S Glendevy,* 1 (CSU); *4 mi. N Rustic,* 1 (CSU); *Sevenmile Creek,* 1 (CU); *Tunnel Campground, Roosevelt National Forest,* 1 (CSU); *Bennett Creek Campground, Roosevelt National Forest,* 2 (1 CSU, 1 CU); *W 1/2 sec. 26, T. 8 N, R. 73 W, 8400 ft.,* 1 (CSU); *5 mi. N, 13 mi. W Fort Collins,* 1 (CSU); *4 mi. N, 12 mi. W Fort Collins,* 1 (CU); *9 mi. W Bellvue,* 1 (CSU); *4 mi. N, 1/2 mi. E Pingree Park, 8500 ft.,* 1 (CSU); Buckhorn Mountain, 1 (CSU); *6 mi. N, 3 mi. W Fort Collins,* 1 (CSU); *Chambers Lake,* 2 (CSU); *3 mi. NW Pingree Park,* 3 (CSU); *42 mi. [by road] W Fort Collins, 8500 ft.,* 1 (CSU); *41 mi. [by road] W Fort Collins, 8500 ft.,* 1 (CSU); *30 mi. W Fort Collins,* 1 (CU); *28 mi. W Fort Collins,* 1 (CSU); *25 mi. W Fort Collins,* 1 (CSU); *23 mi. W Fort Collins,* 4 (1 CSU, 3 CU); *20 mi. W Fort Collins,* 1 (CSU); 2 1/4 mi. W Fort Collins, 1 (CU); *1 mi. N Pingree Park,* 2 (CU); *sec. 15, T. 7 N, R. 73 W,* 1 (CU); *4 mi. E Pennock Pass, 9200 ft.,* 1 (CSU); *20 mi. W Fort Collins,* 1 (CSU); *Crystal Mountain Road at Buckhorn Canyon,* 1 (CU); *sec. 18, T. 7 N, R. 71 W,* 1 (CSU); *SW 1/4 sec. 15, T. 7 N, R. 73 W, 8100 ft.,* 1 (CSU); Pingree Park, 8000 ft., 9 (2 CSU, 7 CU); *Trap Lake, 9600 ft.,* 1 (CSU); *Fall Creek, above Pingree Park, 9800 ft.,* 1 (USNM); *10 mi. S Rustic, 9200 ft.,* 1 (CSU); headwaters Laramie River, 3 (USNM); *1 mi. E Cameron Pass,* 1 (CU); *5 mi. W Drake,* 1 (CSU); Arkins, 1 (USNM); sec. 20, T. 6 N, R. 75 W, 10,100 ft., 1 (CSU); *divide 12 mi. SE Laramie River, 10,000 ft.,* 1 (USNM); *2 mi. N Chasm Falls,* 2 (RMNP); *1 mi. above Chasm Falls,* 1 (RMNP); *Chasm Falls,* 1 (RMNP); *above Hidden Valley,* 1 (RMNP); Estes Park, 5 (1 ANSP, 4 USNM); *2 1/2 mi. SW Estes Park,* 1 (KU); *4 1/2 mi. SW Estes Park,* 1 (KU); *4 mi. S, 2 mi. W Estes Park,* 2 (KU); *3 mi. below Bear Lake,* 1 (RMNP); *Rocky Mountain National Park,* 1 (RMNP); Longs Peak, 5 (USNM); *no locality other than county,* 1 (USNM). RIO BLANCO COUNTY: Marvine, 1 (USNM); *Marvine Lodge,* 1 (SC); South Fork, White River, 7000 ft., 5 (AMNH); *South Fork, White River, 8200 ft.,* 3 (AMNH); South Fork, White River, 9000 ft., 1 (AMNH); White River Plateau, 25 mi. SE Meeker, 2 (USNM); *no locality other than county,* 1 (DMNH). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 2 (CM); West Fork Douglas Creek, 35 mi. S Rangely, 8000 ft., 7 (CM); Rifle Mountain Park, 2 (CU); New Castle, 1 (MCZ); Baxter Pass, 8500 ft., 2 (USNM); *Mud Springs [county line, due N of Silt], 8850 ft.,* 2 (WC). EAGLE COUNTY: near Bond, 1 (DMNH); 1 1/2 mi. E Vail, 8450 ft., 1 (CSU). GRAND COUNTY: Never Summer Ranch, 1 (RMNP); *Timber Creek Campground,* 4 (RMNP); *Timber Creek,* 2 (RMNP); *1 mi. from Grand Lake Entrance, Rocky Mountain National Park,* 1 (RMNP); Grand Lake, 8300 ft., 1 (WC); *3 1/2 mi. SW Grand Lake,* 2 (1 CSC, 1 CSU); 14 mi. NE Kremmling, 1 (CSU); *1 1/2 mi. S Elk Mountain,* 1 (CU); Hot Sulphur Springs, 4 (1 AMNH, 3 WC); *Middle Park,* 1 (USNM); near Parshall, 1 (CU); 14 mi. E Parshall, 1 (CSU); *Coulter,* 3 (1 AMNH, 2 USNM); *Radium,* 1 (FWS); near Sheephorn Pass, 8200 ft., 4 (WC); *near Berthoud Pass,* 1 (USNM), Berthoud Pass, 1 (MCZ). SUMMIT COUNTY: Dillon, 8880 ft., 2 (CSU); *4 mi. S, 3 mi. W Loveland Pass,* 1 (KU); Gray's Peak, 11 (KU); Boreas Pass, 11,470 ft., 1 (WC). BOULDER COUNTY: *James Creek, N of Ward,* 1 (CU); *near Ward,* 1 (CU); Ward, 10,000 ft., 2 (1 CU, 1 USNM); *3 mi. S Ward,* 3 (KU); Bluebell Canyon, near First Flatiron, 1 (CU); *Science Lodge,* 1 (CU); *6 mi. NW Nederland,* 1 (CU); [near] Boulder, 4 (FMNH); *Silver Lake,* 1 (FMNH); *Skunk Canyon, near Green Mountain,* 1 (CU); *N of Nederland, SW of Sugarloaf Mountain,* 1 (WC); *1 mi. N Nederland, 8400 ft.,* 1 (CU); *Fourth of July Campground, Roosevelt National Forest,* 1 (CU); Nederland, 8 (1 ANSP, 1 CU, 5 FMNH, 1 WC); *Dixie Lake,* 1 (DMNH); *3 mi. E Pinecliff,* 1 (UI); *no locality other than county,* 4 (1 CU, 3 USNM). GILPIN COUNTY: Central City, 1 (UMMZ). CLEAR CREEK COUNTY: *Berthoud Pass, 10,000 ft.,* 1 (UMMZ); *Mill Valley,* 2 (AMNH); Idaho Springs, 1 (USNM); *Georgetown,* 1 (USNM); *Silverplume,* 4 (2 DMNH, 1 UI, 1 SC); Loveland Pass, 1 (FWS); *foot of Gray's and Torrey's peaks,* 1 (DMNH); Graymount, 10,000 ft., 1 (SC); *Evans Ranch, Brookvale,* 8 (DMNH); *Echo Lake,* 1 (DMNH); Mount Evans, 10 (CU); *Cone Peak* (not found), 1 (SC); *Kearby Gulch* (not found), 1 (SC); *Radass Park* (not found), 1 (CU); *no locality other than county,* 4 (AMNH). JEFFERSON COUNTY: Ralston Creek, 1 (DMNH); *Denver Mountain Park,* 1 (DMNH); Conifer, 1 (CU); *2 mi. E Conifer, 8500 ft.,* 2 (CSC); Dawson Station, 1 (CSU). MESA COUNTY: *Grand Mesa,* 1 (CSC); Grand Mesa, near Grand Junction, 10,400 ft., 1 (FMNH); [near] Whitewater, 1 (FMNH). PITKIN COUNTY: Aspen, 1 (DMNH); 1 1/2 mi. W Independence Pass, 1 (FMNH). LAKE COUNTY: 1 mi. N, 1 mi. W Leadville, 5 (KU); *8 mi. SW Leadville,* 5 (KU); 9 mi. SW Leadville, 12,000 ft., 6 (KU); *11 mi. SW Leadville, 10,000 ft.,* 19 (KU); *4 mi. W Twin Lakes,* 1 (KU); *3 mi. W Twin Lakes,* 1 (KU); Twin Lakes, 1 (USNM). PARK COUNTY: Hall Valley, 6 (AMNH); *Call [Hall] Valley,* 5 (DMNH); *7 mi. NNW Grant, 9600 ft.,* 1 (FWS); *8 mi. NNW Grant, 10,000 ft.,* 2 (FWS); *Webster,* 1 (DMNH); Bailey, 2 (KU); Kenosha Pass, 10,000 ft., 2 (FWS); 2 1/2 mi. N, 4 mi. W Como, 7900 ft., 1 (CSU); *Montgomery,* 1 (MCZ); *Mount Bross,* 2 (1 DMNH, 1 UI); *Buckskin Ridge, 2 mi. above Alma, 11,500 ft.,* 1 (WC); Alma, 3 (2 DMNH, 1 USNM); *2 1/2 mi. W Fairplay, 10,200 ft.,* 1 (UI); Tarryall Creek, 6 mi. above Puma City, 8700 ft., 1 (WC); Antero Reservoir, 1 (UI); *South Park,* 1 (UI). DELTA COUNTY: Cedaredge, 2 (FMNH). GUNNISON COUNTY: *2 mi. N Schofield Pass,* 1 (WSC); Schofield Pass, 10,700 ft., 1 (UMMZ); *Gothic Natural Area, 9750 ft.,* 1 (UMMZ); *Gothic Mountain, 9500 ft.,* 2 (ANSP); Gothic, 1 (AMNH); Cascadilla, Cement Creek, 1 (WSC); Taylor Reservoir, 1 (WSC); *Crested Butte Peak, 11,000 ft.,* 3 (WC); *West Brush Creek,* 1 (WC); *Middle Brush Creek,* 1 (WC); Crested Butte, 2 (1 MCZ, 1 WC); *Spring Creek, Cochetopa [Gunnison] National Forest,* 1 (USNM); 7 mi. N Almont, 1 (WSC); *10 mi. N Gunnison,* 1 (SCSC); *Cochetopa [Gunnison] National Forest,* 1 (USNM); Black Mesa, 9 mi. WNW Sapinero, 9500 ft., 1 (KU); *Forest Reserve Camp, sec. 7, T. 49 N, R. 4 W, 8250 ft.,* 8 (2 AMNH, 1 CSU, 5 WC); *Coal Creek Canyon,* 3 (KU); 25 mi. SE Crawford, 1 (CU). CHAFFEE COUNTY: Granite, 1 (USNM); *6 mi. E Buena Vista, 8000 ft.,* 1 (FWS); Methodist Mountain, near Salida, 1 (WC); *Poncha Creek, 10 mi. SW Salida, 8500 ft.,* 7 (KU); near Poncha Pass, 8750 ft., 1 (WC). TELLER COUNTY: *13 mi. N Florissant, 8900 ft.,* 1 (FWS); 10 mi. N Florissant, 8900 ft., 1 (FWS); 10 mi. W Woodland Park on U. S. Highway 24, 1 (SCSC); Glen Cove, 11,450 ft., 1 (UMMZ). EL PASO COUNTY: Palmer Lake, 1 (CU); U. S. Air Force Academy, 1 (CSU); *Minnehaha,* 2 (AMNH); 1 1/2 mi. S Manitou Springs, 1 (CSU); *Hunter's Creek, tributary of Bear Creek,* 1 (WC); *10 mi. W Colorado Springs,* 1 (SCSC); Lake Moraine, 4 (WC); *near Cheyenne Canyon,* 1 (WC); *South Cheyenne Creek, 7000 ft.,* 2 (1 AMNH, 1 WC); *no locality other than county,* 2 (MCZ). MONTROSE COUNTY: Black Mesa, near Crawford, 1 (CSU); 5 mi. W Tabeguache Creek, 6000 ft., 1 (USNM). SAGUACHE COUNTY: 5 mi. N, 22 mi. W Saguache, 3 (KU); *Monshower Meadows, 3 mi. W Cochetopa Pass,* 9 (1 FWS, 8 USNM); Cochetopa Pass, 3 (2 KU, 1 USNM);

"Lunatch" Pass, 1 (USNM); Tevebaugh's Ranch, 20 mi. W Saguache, 1 (USNM); 2 mi. N, 2 mi. E Crestone, 8300 ft., 1 (KU). CUSTER COUNTY: 7 mi. SW Wetmore, 1 (SCSC); Querida, 1 (WC); *6 mi. W Buelah,* 1 (SCSC); sec. 11, T. 23 S, R. 69 W, 1 (CU); *ridge N of Marion Lake, 10,000 ft.,* 1 (WC). DOLORES COUNTY: Rico, 1 (USNM). SAN JUAN COUNTY: Silverton, 1 (USNM); *Molas Pass,* 1 (SC). HINSDALE COUNTY: 7 mi. S, 2 mi. W Lake City, 9000 ft., 2 (KU). MINERAL COUNTY: 4 1/2 mi. SW Creede, 1 (CU); Wagon Wheel Gap, 1 (MCZ). RIO GRANDE COUNTY: *Windy Mountain, 11,000 ft.,* 1 (UI); Comstock Campground, 8 mi. S, 11 mi. W Monte Vista, 1 (UI); *Blowout Pass [R. 5 E, T. 37 N],* 3 (UI). ALAMOSA COUNTY: Sangre de Cristo Range, 24 mi. E Hooper, 1 (DMNH). HUERFANO COUNTY: 2 mi. E Medano Pass, 9500 ft., 1 (WC). MONTEZUMA COUNTY: 1/4 mi. NNW Middle Well, Prater Canyon, Mesa Verde National Park, 7600 ft., 1 (KU). ARCHULETA COUNTY: Pagosa Springs, 7100 ft., 1 (WC); Devils Creek, near Dyke, 1 (DMNH); Chromo, 11 (3 AMNH, 8 DMNH); *Navajo River,* 17 (DMNH). CONEJOS COUNTY: *near La Manga Pass,* 2 (WC); La Manga Pass, 1 (WC); Osier, 1 (AMNH). COSTILLA COUNTY: [near] Fort Garland, 3 (1 MCZ, 2 USNM); *"Garland,"* 4 (USNM). LAS ANIMAS COUNTY: Tercio, 1 (WC). County unknown: *Soda Springs,* 1 (USNM); *Jackson Ranger Station, Uncompahgre National Forest,* 3 (SC); *Maderia Creek, 8000 ft.,* 1 (WC).

Additional records (Finley, 1969:242-248, unless otherwise noted): JACKSON COUNTY: *Park Range, near Pearl* (Gordon, 1936:171); *[near] Lake Agnes* (Yeager, 1950:329). RIO BLANCO COUNTY: *Trappers Lake* (Yeager, *loc. cit.*). *5 mi. W Arapahoe Basin; 3 mi. W Arapahoe Basin, 10,000 ft.* GILPIN COUNTY: *NE of Blackhawk, 9000 ft.* JEFFERSON COUNTY: Cub Creek, SW of Evergreen. PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:36); Wellington Lake; Redskin Gulch. DOUGLAS COUNTY: Devil's Head Peak, W of Sedalia (Hatt, 1943:311). GUNNISON COUNTY (Findley and Negus, 1953:236, unless otherwise noted): *Maroon Pass, 11,850 ft.; Copper Creek Trail, 2 2/10 mi. NE Gothic, 10,200 ft.; Gothic Natural Area, 2 mi. NW Gothic, 10,200 ft.; Washington Gulch, 2 4/10 mi. SW Gothic, 9800 ft.; Soap Creek, 4 mi. above Gunnison River, 7500 ft.* (Durrant and Robinson, 1962:248). HUERFANO COUNTY: Sangre de Cristo Pass (Coues and Yarrow, 1875:117). RIO GRANDE COUNTY: Beaver Creek, 8300 ft. MONTEZUMA COUNTY: *Chickaree Draw, Prater Canyon, Mesa Verde National Park* (Anderson, 1961:41). County unknown: *Chihuahua Creek* (Coues and Yarrow, 1875:117).

FAMILY GEOMYIDAE—POCKET GOPHERS

KEY TO SPECIES OF GEOMYIDAE IN COLORADO

1. Upper incisors lacking conspicuous longitudinal groove 2

   Upper incisors with conspicuous longitudinal grooves 3

2. Upper incisors procumbent; interparietal longer than broad, not extending posteriorly past supraoccipital crest; sphenoidal fissure present .... *Thomomys bottae*

   Upper incisors decumbent; interparietal broader than long, extending posteriorly past supraoccipital crest; sphenoidal fissure absent .... *Thomomys talpoides*

3. Color dark, rich yellowish to orangish brown; upper incisors with one longitudinal groove .... *Pappogeomys castanops*

   Color pale, yellowish to grayish buff; upper incisors with two longitudinal grooves .... *Geomys bursarius*

Thomomys bottae

VALLEY POCKET GOPHER

Thomomys bottae occurs in western North America from California to Colorado and New Mexico, and from Oregon southward to Sinaloa and Coahuila. In Colorado, the species is mostly restricted to well-developed soils of warm valleys in the southern part of the state, although on the eastern slope of the Sangre de Cristo Range and the Park Plateau, valley pocket gophers may occupy montane meadows with more organic soils.

As is generally true of pocket gophers, sympatry of two species in Colorado is unknown. At a number of places in the state, the ranges of two or three species approach each other closely, but, insofar as is known, contiguous allopatry, or parapatry, always is maintained. The relationship between *T. bottae* and *T. talpoides* in western Fremont County was documented by Vaughan (1963, 1967b) and by Vaughan and Hansen (1964). R. S. Miller (1964) discussed relationships among species of pocket gophers in theoretical terms. Douglas (1969a) investigated the ecology of *T. bottae* on Mesa Verde.

Six subspecies of *T. bottae* are recognized in Colorado. Each population is at least partially isolated and intergradation between them in the state has not been documented. Youngman (1958) reviewed the taxonomy of

T. bottae in Colorado, and that study is followed in the accounts of subspecies below. Hall and Kelson (1959:413-434) treated Coloradan valley pocket gophers as subspecies of *T. umbrinus.* For details on relationships between *T. bottae* and *T. umbrinus,* see Hoffmeister (1969).

Because of their ecological and economic importance, and also their complex microevolutionary history, pocket gophers in Colorado have been the subject of more research than any other group of non-game mammals. Much of that research has been conducted under the auspices of the Colorado Cooperative Pocket Gopher Project, a program involving personnel of the Agricultural Experiment Station of Colorado State University, the Denver Wildlife Research Center of the Bureau of Sport Fisheries and Wildlife, the Rocky Mountain Forest and Range Experiment Station of the U.S. Forest Service, and the Colorado Cattlemen's Association. Comprehensive publications on Coloradan pocket gophers include an ecological account by R. S. Miller (1964), and a semi-technical publication, "Pocket gophers in Colorado" (Hansen, 1960a). For literature on the economic importance of Coloradan pocket gophers in the first three decades of the present century, the reader is directed to Annual Reports and Circulars of the Office of the State Entomologist.

Thomomys bottae aureus J. A. Allen

Thomomys aureus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:49, 28 April 1893; type locality, Bluff City, San Juan Co., Utah.

Thomomys bottae aureus, Goldman, Proc. Biol. Soc. Washington, 48:156, 31 October 1935.

Thomomys bottae optabilis Goldman, Jour. Washington Acad. Sci., 26:116, 15 March 1936; type locality, Coventry, 6500 ft., Montrose Co., Colorado (regarded as inseparable from *aureus* by Youngman, 1958:37).

Distribution in Colorado.—Valleys of southwestern part of state, south of Uncompahgre Plateau and south and west of San Juan Mountains (Fig. 54).

Comparisons.—From *T. b. pervagus,* the subspecies of the San Luis Valley, *T. b. aureus* differs as follows (after Youngman, 1958:373): color generally more yellowish; posterior extensions of premaxillaries wider, more deeply serrate; posterior margins of nasals truncate, not forming a V-shaped notch; basioccipital narrower.

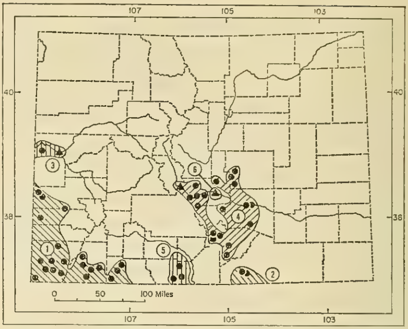


FIG. 54. Distribution of *Thomomys bottae* in Colorado. 1. *T. b. aureus.* 2. *T. b. cultellus.* 3. *T. b. howelli.* 4. *T. b. internatus.* 5. *T. b. pervagus.* 6. *T. b. rubidus.* For explanation of symbols, see p. 9.

For comparison with *T. b. howelli,* the subspecies of the Grand Valley, see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of nine males, followed by those of nine females, all from Montezuma County, are: 240.9 (215-257), 225.0 (217-232); 74.4 (62-81), 65.5 (61-73); 30.8 (28-33), 29.0 (26-32); —, 6.0 (5-7); mean and extreme weights of five males, 192.6 (167-221), of eight females, 150.2 (134-175).

Average (and extreme) external measurements of four males, followed by those of four females, all from La Plata and Archuleta counties, are: 246.0 (236-262), 216.5 (208-230); 75.2 (70-87), 64.8 (63-66); 31.5 (29-35), 29.8 (27-32); 6.0 (6-6), 6.0 (6-6); mean weight of four males, 189.4 (173-215), weights of two females, 142, 132. Selected cranial measurements are presented in table 13.

Remarks.—Coloradan pocket gophers from La Plata County had been considered to represent a subspecies *(apache)* distinct from *aureus.* Youngman (1958:371) considered *apache* to be a synonym of *aureus,* and described clinal variation in color in valley pocket gophers of the San Juan drainage. Youngman *(loc. cit.)* is followed herein, although Durrant and Dean (1961:168) maintained a distinction between *apache* and

TABLE 13

Selected cranial measurements of six subspecies of *Thomomys bottae*.

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital breadth	Mastoid breadth	Breadth of rostrum	Length of nasals	Length of maxillary toothrow
Thomomys bottae aureus, Montezuma County								
Mean, 9 ♂	43.24	37.97	27.40	6.49	22.08	8.94	14.91	8.71
Minimum	40.8	35.7	25.2	6.1	20.7	8.6	12.1	8.1
Maximum	45.0	39.8	28.4	6.7	23.0	9.6	15.4	9.1
Mean, 9 ♀	39.27	34.38	24.65	6.48	20.22	8.06	13.12	8.28
Minimum	37.8	32.6	23.2	6.1	19.6	7.7	12.0	7.8
Maximum	40.5	35.9	25.6	7.1	21.2	8.7	14.6	8.9
La Plata and Archuleta counties								
Mean, 4 ♂	44.00	39.20	27.98	6.40	22.48	8.88	14.90	8.78
Minimum	42.5	37.4	27.2	6.2	21.7	8.7	14.0	8.4
Maximum	44.3	39.9	29.3	6.5	23.2	9.3	15.6	9.4
Mean, 4 ♀	38.45	33.90	24.70	6.40	19.85	7.80	12.92	8.28
Minimum	37.3	32.8	23.6	6.2	19.1	7.4	12.7	7.7
Maximum	40.0	35.2	25.8	6.5	21.1	8.0	13.2	8.6
Thomomys bottae cultellus, 2 1/2 mi. S Trinidad, Las Animas County								
KU 76787, ♂	42.4	37.4	27.1	7.6	21.0	8.6	15.6	8.6
Thomomys bottae howelli, Mesa County								
WC 4082, ♂	42.2	36.7	28.8	6.4	23.3	10.8	14.5	8.5
USNM 75684, ♀	37.3	32.3	23.8	6.6	20.0	8.5	11.1	8.0
Thomomys bottae internatus, Salida, Chaffee County								
Mean, 7 ♀	37.63	32.86	22.41	6.55	19.07	7.51	13.50	7.94
Minimum	36.9	31.9	21.9	6.4	18.6	7.2	12.9	7.6
Maximum	38.5	33.6	23.1	6.8	19.6	7.7	13.8	8.5
El Paso, Pueblo, and Huerfano counties								
Mean, 5 ♂	41.60	36.58	26.32	6.16	21.02	8.52	15.28	8.34
Minimum	39.8	35.3	25.0	5.8	19.8	8.2	14.3	8.0
Maximum	42.5	37.6	27.6	6.4	22.0	8.8	16.4	8.6
Mean, 12 ♀	38.23	33.25	23.14	6.61	19.28	7.53	13.32	7.98
Minimum	36.9	32.2	22.4	6.1	18.2	7.0	12.8	7.2
Maximum	39.4	34.1	24.7	7.0	20.1	7.8	14.2	8.5
Thomomys bottae pervagus, 1/2 mi. N La Jara, Conejos County								
KU 76782, ♂	43.1	37.2	27.7	7.6	21.6	9.0	15.2	8.0
KU 76781, ♀	39.9	34.7	23.8	6.2	19.4	7.9	13.5	8.2
Thomomys bottae rubidus, 2 9/10 mi. E Cañon City, Fremont County								
KU 72949, ♂	44.5	39.4	27.8	6.8	22.5	10.2	15.4	8.0
KU 72950, ♂	44.1	38.3	27.3	7.0	22.4	10.2	15.8	7.8
KU 72951, ♂	44.8	39.3	27.8	6.7	22.4	9.7	15.7	8.0
KU 72952, ♀	40.4	34.9	25.0	6.8	20.7	8.7	14.2	7.5
KU 72954, ♀	40.3	35.3	24.6	6.9	20.6	9.2	14.2	7.2

aureus in northern New Mexico, based mostly on color.

Records of occurrence.—Specimens examined, 184, distributed as follows: MONTROSE COUNTY: West Paradox Valley, 5 (DMNH); Bedrock, 5 (WC); Coventry, 22 (6 AMNH, 1 USNM, 15 WC). SAN MIGUEL COUNTY: *Norwood,* 12 (SC); 19 mi. N Dove Creek, 3 CU). MONTEZUMA COUNTY: 7 mi. N Dolores, 2 (UNM); *sec. 2, T. 35 N, R. 19 W, 15 mi. W Cortez, 5400 ft.,* 8 (KU); Cortez, 9 (CSU); Mancos, 9 (SC); Ashbaugh's Ranch [Moqui], 1 (USNM); *3 mi. SSW Cortez, 6400 ft.,* 1 (KU); *1/4 mi. N Upper Well, Prater Canyon, Mesa Verde National Park, 7500 ft.,* 1 (KU); *Upper Well, Prater Canyon, 7575 ft.,* 1 (KU); *Morfield Canyon, 7600 ft.,* 1 (KU); *Park Point,* 11 (KU); Ute Peak, 2 (DMNH); *3/4 mi. S, 1 3/4 mi. W Park Point, 8000 ft.,* 3 (KU); *Prater Canyon, 7500 ft.,* 1 (KU); *Middle Well, Prater Canyon, 7500 ft.,* 1 (KU); *1 1/2 mi. S, 2 mi. W Park Point, 8075 ft.,* 1 (KU); *1 1/2 mi. S, 1 3/4 mi. W Park Point,* 1 (KU); 3 mi. N Rock Springs, 8200 ft., 4 (KU); *head East Fork Navajo Canyon, 7900 ft.,* 2 (KU); *6 8/10 mi. S North Rim, Moccasin Mesa,* 3 (KU); *2 1/2 mi. N, 1/2 mi. W Rock Springs, 8100 ft.,* 3 (KU); *2 mi. N, 1/2 mi. W Rock Springs, 7900 ft.,* 2 (KU); *1/2 mi. N Far View Ruins, 7825 ft.,* 1 (KU); *8 mi. S North Rim, Moccasin Mesa,* 3 (KU); *Far View Ruins, 7700 ft.,* 1 (KU); *1 mi. NNW Rock Springs, 7500 ft.,* 1 (KU); *1/2 mi. NNW Rock Springs, 7500 ft.,* 1 (KU); Mancos River, 6200 ft., 9 (KU); *Rock Springs, 7400 ft.,* 1 (KU); *Chapin Mesa, 1 2/10 mi. S Far View Road,* 1 (KU); *Mesa Verde,* 1 (USNM); Four Corners, 1 (DMNH). LA PLATA COUNTY: 1 mi. N La Plata, 1 (KU); 3 mi. W Durango, 5 (KU); Bayfield, 1 (USNM); *Los Piños [Bayfield],* 1 (USNM); Florida, 5 (KU); Bondad, 6 (DMNH). ARCHULETA COUNTY: 12 mi. W Pagosa Springs, 6700 ft., 1 (KU); mouth of Archuleta Cañon, 1 (UNM); *near mouth of Deep Cañon,* 1 (UNM); Arboles, 1 (USNM); *NE 1/4, SE 1/4 sec. 18, T. 32 N, R. 4 W,* 1 (UNM).

Thomomys bottae cultellus Kelson

Thomomys bottae cultellus Kelson, Univ. Kansas Publ., Mus. Nat. Hist., 5:64, 1 October 1951; type locality, Halls Peak, Mora Co., New Mexico.

Distribution in Colorado.—Suitable habitat in Raton Section; limits of range unknown (Fig. 54).

Comparisons.—From *T. b. internatus,* the subspecies to the north, *T. b. cultellus* differs in markedly darker color, more widely flaring zygomatic arches, and wider nasals (see Kelson, 1951b:66; Youngman, 1958:375). For comparison with *T. b. pervagus,* see account of that subspecies.

Measurements.—External measurements of a male from 2 1/2 mi. S of Trinidad and a young adult female from Fisher Peak are: 249, 214; 80, 64; 32, 27; weight of the male, 185. Selected cranial measurements are presented in table 13.

Remarks.—Youngman (1958:375) compared topotypes of *internatus* with those of *cultellus* and concluded that certain cranial details supposed by Kelson (1951b:66) to be distinctive of the latter subspecies were, in fact, not so.

The single Coloradan specimen referred to *cultellus* by Kelson *(loc. cit.)* was considered by him, because of its pale color, as perhaps an intergrade between that subspecies and *internatus.* It is impossible to characterize the population of *T. bottae* in southern Las Animas County on the basis of the single adult specimen now available. I follow Kelson *(loc. cit.)* and Youngman *(loc. cit.)* in identifying the above-mentioned specimens with *cultellus.*

Records of occurrence.—Specimens examined, 3, distributed as follows: LAS ANIMAS COUNTY: 2 1/2 mi. S Trinidad, 2 (KU); Fisher Peak, 1 (USNM).

Thomomys bottae howelli Goldman

Thomomys bottae howelli Goldman, Jour. Washington Acad. Sci., 26:116, 15 March 1936; type locality, Grand Junction, 4600 ft., Mesa Co., Colorado.

Distribution in Colorado.—Known only from Mesa County (Fig. 54).

Comparisons.—From *T. b. aureus,* the subspecies of the San Juan drainage to the south, *T. b. howelli* differs in generally paler color and in cranial details: ". . . braincase conspicuously broader and flatter; zygomata more widely spreading; nasals shorter; premaxillae more attenuate posteriorly; interparietal larger, audital bullae more rounded and inflated anteriorly; incisors . . . less strongly recurved" (Goldman, 1936:116).

From *T. b. osgoodi,* the subspecies west of the Colorado and Green rivers in Utah, *T. b. howelli* differs in having ". . . skull much larger, with flatter braincase, shorter nasals, and posteriorly narrower premaxillae" (Goldman, *loc. cit.*).

Measurements.—External measurements of a male from Sieber Ranch and a young adult female (the holotype, USNM 75684) from Grand Junction are: 238, 219: 67, 71; 33, 29; 8, —. For cranial measurements, see table 13.

Remarks.—*Thomomys b. howelli* is poorly known, but apparently is a distinctive population isolated by the Green River, the Book Cliffs, and the Uncompahgre Plateau from other subspecies of *T. bottae.* Durrant (1952: 211) considered specimens from a place 10 mi. N of Moab, Grand Co., Utah, to be intergrades between *howelli* and *osgoodi* in cranial details, although some individuals, by their color, suggested intergradation with *aureus.* In Colorado, the range of *T. b. howelli* does not approach that of any other population of valley pocket gopher.

Records of occurrence.—Specimens examined, 4, distributed as follows: MESA COUNTY: Grand Junction, 1 (USNM); Sieber Ranch, Little Dolores Creek, 3 (WC).

Thomomys bottae internatus Goldman

Thomomys bottae internatus Goldman, Jour. Washington Acad. Sci., 26:115, 15 March 1936; type locality, Salida, 7000 ft., Chaffee Co., Colorado.

Distribution in Colorado.—Suitable habitat in Arkansas River drainage, eastward at least to Pueblo (see remarks beyond and Fig. 54).

Comparisons.—For comparisons with geographically adjacent subspecies, see accounts of those taxa.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of seven females, all from the type locality, are: 243.8 (233-248), 212.4 (204-220); 76.0 (73-83), 62.9 (57-70); 32.0 (31-33), 30.1 (29-31). Mean (and extreme) external measurements of five males, followed by those of 12 females, all from the eastern part of the known range of the subspecies (El Paso, Pueblo, Huerfano counties), are: 242.0 (226-254), 222.0 (212-232); 77.2 (63-88), 69.9 (64-77); 30.4 (28-32), 28.4 (25-31); 7.0 (6-8), 6.2 (5-8); mean and extreme weights of three males, 168.13 (146.4-181.9), of six females, 123.75 (111.6-141.0). Representative cranial measurements are presented in table 13.

Remarks.—The limits of the range of *T. b. internatus* are poorly known at present. In the valley of the Arkansas River, the range is interrupted in the vicinity of Cañon City by a distinctive, local race, *T. b. rubidus,* and perhaps to some extent by the Royal Gorge of the Arkansas. Communication of the population of the Upper Arkansas River Valley with that below Cañon City may be via the Wet Mountain Valley, although no specimens are available from the central part of the valley, on either side of Promentory Divide.

Youngman (1958:374) discussed local variation within this subspecies.

Records of occurrence.—Specimens examined, 98, distributed as follows: CHAFFEE COUNTY: *3 mi. N Salida,* 4 (KU); *2 mi. N Salida,* 3 (KU); Salida, 28 (7 USNM, 21 WC). EL PASO COUNTY: 1 1/4 mi. S Colorado Springs, 2 (KU); *1 1/2 mi. S Colorado Springs,* 2 (KU); *3 1/2 mi. S Colorado Springs,* 2 (KU); 9 mi. SSW Colorado Springs, 6500 ft., 4 (KU); 17 mi. S Colorado Springs, 1 (KU). FREMONT COUNTY: *Red Canyon, 14 7/10 mi. N Cañon City,* 1 (KU); Red Canyon, 12 mi. N Cañon City, 1 (CSU); 16 mi. WNW Cañon City, 1 (KU); 5 3/10 mi. S Texas Creek, 4 (KU); Cotopaxi, 1 (CSU); 1 mi. W Coaldale, 3 (KU); *1 mi. E Coaldale,* 3 (KU); *5 3/10 mi. SSE Cotopaxi,* 4 (KU); *5 mi. S Cotopaxi,* 3 (1 CSU, 2 KU); 8 mi. S Cotopaxi, 1 (KU). CUSTER COUNTY: 2 1/2 mi. S Wetmore, 3 (KU). PUEBLO COUNTY: Roselawn Cemetery, Pueblo, 1 (SCSC); *Santa Fe Drive at 20th Lane, Blende,* 1 (KU); 200 yards E St. Charles River, 8 mi. W [E] Pueblo, 3 (KU); *St. Charles Mesa, 4600 ft.,* 2 (CSU); junction Huerfano and Cucharas rivers, 2 (DMNH). HUERFANO COUNTY: 11 mi. WNW Gardner, 3 (KU); Gardner, 7000 ft., 2 (USNM); 1 1/2 mi. S Redwing, 3 (KU); Bear Creek, near Walsenburg, 6187 ft., 2 (CSU); *La Veta,* 2 (CU); *1 mi. E La Veta,* 5 (KU); 5 mi. SE La Veta, 1 (KU).

Additional record: FREMONT COUNTY: *6 mi. N Cotopaxi, 7500 ft.* (Vaughan, 1963:367).

Thomomys bottae pervagus Merriam

Thomomys aureus pervagus Merriam, Proc. Biol. Soc. Washington, 14:110, 19 July 1901; type locality, Espanola, Rio Arriba Co., New Mexico.

Thomomys bottae pervagus, Goldman, Proc. Biol. Soc. Washington, 48:157, 31 October 1935.

Distribution in Colorado.—Known only from the San Luis Valley south and west of the Rio Grande (Fig. 54).

Comparisons.—From *T. b. internatus,* the subspecies of the Arkansas River Valley, *T. b. pervagus* differs in richer, more reddish color, larger external and cranial size, and in cranial details (see Youngman, 1958:374). From *T. b. cultellus,* the subspecies of the Raton Section, *T. b. pervagus* differs in slightly paler (more reddish and less brownish) color, larger external and cranial size, and in cranial details (Kelson, 1951b:66; Youngman, 1958:375). For comparison with *T. b. aureus,* see account of that subspecies.

Measurements.—External measurements of a male and a female from 1/2 mi. N of La Jara are: 251, 239; 78, 78; 32, 31; weights, 205, 124. Selected cranial measurements are presented in table 13.

Records of occurrence.—Specimens examined, 42, distributed as follows: CONEJOS COUNTY: 1/2 mi. N La Jara, 3 (KU); *La Jara,* 6 (UNM); *2 mi. N Antonito,* 3 (KU); 2 mi. N, 3 4/10 mi. E Antonito, 21 (UNM); *Antonito,* 8 (USNM); *Conejos River, 8200 ft.,* 1 (USNM); Conejos River, 8300 ft., 1 (USNM).

Thomomys bottae rubidus Youngman

Thomomys bottae rubidus Youngman, Univ. Kansas Publ., Mus. Nat. Hist., 9:376, 21 February 1958; type locality, 2 9/10 mi. E Cañon City, 5344 ft., Fremont Co., Colorado.

Distribution in Colorado.—Known only from the immediate vicinity of the type locality (Fig. 54).

Comparison.—From *T. b. internatus,* the widespread subspecies of the Arkansas River drainage, *T. b. rubidus* differs in darker (more brownish, less orangish) color, larger average cranial size (except length of maxillary toothrow), distinctly tapered rostrum, and more rounded zygomata. For more extensive comparisons, see Youngman (1958:377).

Measurements.—External measurements of three males and two females (including the holotype) from the type locality are, respectively: 259, 270, 255, 233, 225; 85, 94, 88, 80, 80; 30, 32, 32, 28, 28; weights, 218, 204, 196, 144, 128. Selected cranial measurements are presented in table 13.

Remarks.—The range of *T. b. rubidus* apparently is surrounded by that of *T. b. internatus,* but intergradation between the two named populations has not been demonstrated.

Records of occurrence.—Specimens examined, 7, distributed as follows: FREMONT COUNTY: *Cañon City,* 1 (DMNH); 2 9/10 mi. E Cañon City, 6 (KU).

Thomomys talpoides

NORTHERN POCKET GOPHER

Thomomys talpoides has the broadest geographic and altitudinal range of Coloradan pocket gophers. It also has the broadest ecological tolerance, occurring in greatest numbers on deep sandy soils, but colonizing heavy clays and coarse, gravelly soils as well. The altitudinal range is from about 5000 feet in northern Weld County to well above timberline in alpine meadows. Hansen and Beck (1968) discussed the habitat of *T. talpoides* in the Cochetopa Creek drainage. R. S. Miller (1964) commented on soil preferences of Coloradan pocket gophers.

Detailed studies of food habits of the northern pocket gopher have been published by Ward (1960), Ward and Keith (1962), and Vaughan (1967a). R. S. Miller (1958) discussed the rate of growth of incisors. Hansen and Ward (1966) discussed the effect of *T. talpoides* on rangeland on Grand Mesa, and Tietjen *et al.* (1967) reported on pocket gopher control with 2, 4-D on Black Mesa (also see Johnson and Hanson, 1969, and Keith *et al.,* 1959).

The burrowing of northern pocket gophers is of great importance where the animals are abundant. The combined effects of *T. talpoides* and domestic sheep have conspicuously damaged the alpine vegetation at a number of localities in Colorado. Superficial observations in the vicinity of Cinnamon Pass, Hinsdale County, in the summer of 1969, suggest that detailed study of such damage would be of interest. Ellison (1948) studied the influence of pocket gophers on erosion on the Wasatch Plateau of Utah. Miller and Bond (1960) reported on summer burrowing on Black Mesa. Soil casts typical of winter activity were illustrated by Hansen (1967). Hansen and Morris (1968) noted the movement of rocks by *T. talpoides.*

The possible influence of burrowing by pocket gophers on certain sorts of micro-relief has been widely debated. Gravel mounds at Rocky Flats, northwest of Denver, commonly are linked to the work of *T. talpoides.* For discussion of the relationships of pocket gophers and micro-relief, see Scheffer (1958), Hansen (1962a), Branson *et al.* (1965), and Murray (1967).

Except during the breeding season, pocket gophers are solitary and highly territorial. Hansen and Miller (1959) discussed the incidence and importance of plural captures in burrow systems. Hansen (1965) investigated population density in an enclosure study on Black Mesa, and Hansen and Remmenga (1961) discussed the relationship between density and the size of the territory. Methods of censusing pocket gophers were detailed by Reid *et al.* (1966). Utilization of burrow systems by other kinds of vertebrates was documented by Vaughan (1961a). Hansen (1960b) discussed age structure and reproductive characteristics of several populations of northern pocket gophers, and Hansen and Bear (1964) compared mensural and reproductive characteristics of populations in three contrasting habitat-types in the Cochetopa Creek drainage. Color aberrations in Coloradan pocket gophers were noted by Burnett (1925), and discussed in theoretical terms by Storer and Gregory (1934).

Infraspecific taxonomy of species of *Thomomys* is a frequent target for opponents of the subspecies category (see Anderson, 1966). Those acquainted with the range and mode of variation in these animals are aware, however, that there are few mammalian groups in which geographic variation in various characters is so marked or so nearly concordant. In most cases, identification of specimens with named kinds on the basis of external and cranial characters is not difficult, and boundaries of subspecies can be delineated with some confidence.

The problem with subspecies of pocket gophers is not that there are too many of them, but that biological relationships among named populations seldom are known, and the evolutionary role of supposed subspecies is uncertain. Local populations of species of *Thomomys* tend to be disjunct, limited by strict habitat requirements. The complex physiography of western North America dictates fragmented ranges and isolation of populations. Intergradation between nominal subspecies seldom has been demonstrated. In the absence of either sympatry or intergradation, an empirical basis is lacking to judge whether or not populations are reproductively isolated.

A biosystematic study of *T. talpoides* in Colorado and adjacent areas currently is being made by Dr. C. S. Thaeler, Jr., of New Mexico State University. Thaeler (1968) published preliminary results of karyological studies of *T. talpoides*. Widely divergent chromosomal patterns are seen in samples from several local populations in Colorado. A tentative conclusion is that a number of populations subsumed under the specific name *talpoides* are, in fact, distinct biological species. Until evolutionary relationships of the several populations have been worked out in detail, however, to continue to treat members of the "*Thomomys talpoides* complex" as subspecies seems to me to be the conservative course.

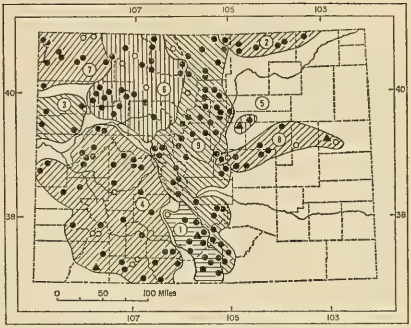


FIG. 55. Distribution of *Thomomys talpoides* in Colorado. 1. *T. t. agrestis.* 2. *T. t. attenuatus.* 3. *T. t. durranti.* 4. *T. t. fossor.* 5. *T. t. macrotis.* 6. *T. t. meritus.* 7. *T. t. ocius;* 8. *T. t. retrorsus.* 9. *T. t. rostralis.* For explanation of symbols, see p. 9.

Thomomys talpoides agrestis Merriam

Thomomys talpoides agrestis Merriam, Proc. Biol. Soc. Washington, 21:144, 9 June 1908; type locality, Medano Ranch, 15 mi. NE Mosca, Alamosa Co., Colorado.

Distribution in Colorado.—San Luis Valley, north and east of the Rio Grande (Fig. 55).

Comparisons.—From both *T. t. fossor* and *T. t. rostralis,* subspecies of the mountains to the west and east, respectively, *T. t. agrestis* differs in generally smaller size (both externally and cranially) and markedly paler (grayish to yellowish buff) color.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of five females, all from the type locality, are: 230.8 (224-240), 220.4 (203-226); 65.0 (58-72), 62.4 (52-72); 30.2 (30-31), 30.2 (29-31). For cranial measurements, see table 14.

Remarks.—Specimens from Medano Cañon are darker in color than topotypes, perhaps indicating intergradation with *T. t. rostralis.*

TABLE 14

Selected cranial measurements of nine subspecies of *Thomomys talpoides.*

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital breadth	Mastoid breadth	Breadth of rostrum	Length of nasals	Length of maxillary toothrow
Thomomys talpoides agrestis, Medano Ranch, 15 mi. NE Mosca, Alamosa County								
Mean, 4 ♂	39.75	34.58	23.60	6.40	19.55	8.35	15.17	7.82
Minimum	38.8	33.6	23.1	6.2	19.2	8.1	14.4	7.7
Maximum	41.0	35.9	23.9	6.8	20.0	8.7	15.8	8.0
Mean, 5 ♀	39.18	34.18	23.43	6.58	19.54	8.46	14.98	7.92
Minimum	37.5	32.3	21.8	6.4	18.0	8.2	14.4	7.7
Maximum	40.4	35.2	24.7	7.0	20.5	8.7	16.1	8.1
Thomomys talpoides attenuatus, 10 mi. NE Avalo, *in* Logan County								
USNM 159689, ♂	37.2	32.4	----	6.2	19.3	7.5	14.2	7.0
Mean, 4 ♀	35.30	30.68	21.65	5.95	18.38	7.70	13.90	6.80
Minimum	34.4	29.9	20.5	5.6	17.8	7.5	13.5	6.5
Maximum	36.4	31.6	23.1	6.3	18.8	7.9	14.4	7.1
Thomomys talpoides durranti, 22 mi. SW Meeker, Rio Blanco County								
TCWC 4035, ♂	36.4	31.7	22.4	5.7	19.3	7.5	14.4	7.1
TCWC 4037, ♂	37.2	32.7	21.8	5.8	18.5	7.3	13.8	6.9
TCWC 4033, ♀	36.2	31.6	21.2	5.9	18.8	7.2	13.4	7.3
TCWC 4034, ♀	36.1	31.5	----	6.1	19.5	7.8	13.9	7.3
TCWC 4038, ♀	35.9	31.4	----	5.7	18.0	7.3	13.9	7.0
28 mi. N, 5 mi. W Mack, *in* Garfield County								
Mean, 4 ♀	36.02	31.80	21.17	6.18	18.15	7.30	13.70	6.80
Minimum	35.2	30.9	20.9	6.0	17.7	7.1	12.8	6.4
Maximum	36.9	32.9	21.5	6.3	18.5	7.6	14.6	7.1
Thomomys talpoides fossor, Florida, La Plata County								
AMNH 4120, ♂	39.0	34.8	----	5.8	19.6	7.7	----	8.3
AMNH 4119, ♀	35.1	30.6	21.0	6.2	17.6	7.2	13.0	7.2
Black Mesa, Gunnison County								
Mean, 9 ♀	35.31	31.02	20.69	6.34	17.32	6.93	13.74	7.12
Minimum	34.6	30.4	19.9	6.1	16.8	6.6	13.2	6.7
Maximum	36.2	31.8	21.4	6.8	18.4	7.2	14.2	7.4
Grand Mesa, Mesa and Delta counties								
Mean, 6 ♂	37.33	33.12	22.86	6.12	18.62	7.35	14.42	7.23
Minimum	36.8	32.7	22.5	5.8	18.2	7.2	13.8	6.9
Maximum	38.0	33.8	23.1	6.3	19.3	7.6	15.1	7.6
Mean, 5 ♀	35.70	31.42	21.84	6.36	18.14	7.34	13.80	7.14
Minimum	34.4	30.3	20.8	6.1	17.8	7.0	13.2	6.7
Maximum	36.9	31.6	22.8	6.6	18.7	7.6	14.5	7.5
Thomomys talpoides macrotis, 2 mi. N Parker, Douglas County								
DMNH 2412, ♂	41.1	37.1	26.1	6.2	20.5	8.2	15.2	7.1
Thomomys talpoides meritus, vicinity of Savery, Carbon County, Wyoming								
Mean, 5 ♀	35.38	30.84	21.83	6.20	17.80	7.26	13.18	6.88
Minimum	34.2	30.0	21.6	6.0	16.7	6.9	12.4	6.3
Maximum	36.7	32.0	22.0	6.4	18.8	7.3	13.8	7.2

TABLE 14 (Continued)

Selected cranial measurements of nine subspecies of *Thomomys talpoides.*

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital breadth	Mastoid breadth	Breadth of rostrum	Length of nasals	Length of maxillary toothrow
Toponas Creek Campground, Routt County								
Mean, 4 ♂	36.05	31.82	21.22	6.25	18.30	7.30	13.58	7.55
Minimum	35.0	30.7	20.0	6.0	17.6	7.1	13.0	7.4
Maximum	38.2	33.7	23.5	6.4	19.4	7.6	14.3	7.9
Mean, 7 ♀	35.64	31.21	20.50	6.16	17.89	7.26	13.38	7.19
Minimum	34.3	30.1	19.7	5.6	17.3	6.9	12.4	6.7
Maximum	36.6	32.2	21.0	6.6	18.3	7.8	13.7	7.5
Dry Fork, White River, W of Buford, Rio Blanco County								
Mean, 7 ♀	36.37	31.48	20.97	6.20	18.58	7.33	13.94	7.36
Minimum	35.3	30.2	20.6	5.9	18.0	7.1	13.2	6.8
Maximum	37.6	32.9	21.7	6.7	19.5	7.6	15.0	7.8
1 mi. S Deep Lake, Garfield County								
Mean, 4 ♀	35.10	30.45	20.13	6.18	17.70	7.05	13.45	7.20
Minimum	34.2	29.8	20.0	5.9	17.4	6.9	12.8	7.0
Maximum	35.8	31.4	20.3	6.4	17.9	7.2	13.8	7.3
Thomomys talpoides ocius, Sunbeam, Moffat County								
CSU 5165, ♂	34.0	29.3	19.1	6.4	17.4	7.0	—	7.4
CSU 5024, ♀	32.8	27.1	18.8	5.9	16.8	6.6	11.8	6.8
Craig, Moffat County								
WC 2302, ♀	32.9	28.4	19.6	5.8	17.0	6.8	11.7	6.9
WC 2303, ♀	35.3	30.6	—	6.3	18.5	7.2	13.1	7.2
Thomomys talpoides retrorsus, vicinity of Colorado Springs, El Paso County								
WC 290, ♂	34.3	30.1	19.1	5.7	17.1	7.1	12.5	6.4
WC 334, ♂	36.5	32.0	21.1	5.2	18.1	7.0	13.5	7.2
Mean, 5 ♀	34.14	29.78	19.76	5.58	17.24	7.10	12.72	7.10
Minimum	33.5	28.8	19.7	5.0	16.9	7.0	12.3	6.7
Maximum	34.9	30.3	19.8	6.0	17.9	7.2	13.0	7.6
Thomomys talpoides rostralis, immediate vicinity of Laramie, Albany County, Wyoming								
Mean, 4 ♂	37.38	32.80	22.47	6.34	18.84	7.66	14.70	7.94
Minimum	36.8	32.1	21.8	6.0	18.2	7.2	13.8	7.5
Maximum	38.1	33.7	23.7	6.5	19.4	8.2	15.2	8.3
Mean, 8 ♀	36.82	32.04	22.56	6.44	18.68	7.75	14.51	8.11
Minimum	36.0	30.7	21.4	6.0	17.6	7.1	13.9	7.8
Maximum	39.4	33.6	23.9	7.0	20.1	8.4	15.3	8.6
1 mi. N Livermore, Larimer County								
Mean, 28 ♂	39.62	34.53	23.72	6.17	20.00	8.25	15.21	7.75
Minimum	37.1	32.6	21.7	5.7	19.0	7.5	14.1	7.1
Maximum	42.2	36.5	25.1	6.8	21.6	9.2	16.8	8.4
Mean, 27 ♀	38.32	33.37	22.91	6.17	19.18	7.92	14.53	7.68
Minimum	36.7	31.5	21.4	5.5	18.3	7.4	13.6	7.1
Maximum	40.7	35.5	24.5	6.7	20.3	8.8	15.6	8.1

TABLE 14 (Continued)

Selected cranial measurements of nine subspecies of *Thomomys talpoides.*

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital breadth	Mastoid breadth	Breadth of rostrum	Length of nasals	Length of maxillary toothrow
			southwestern Huerfano County					
Mean, 4 ♂	39.22	34.12	23.25	6.12	19.58	7.98	15.75	7.48
Minimum	38.4	32.8	22.4	5.9	19.3	7.7	14.1	7.1
Maximum	40.2	35.2	23.9	6.4	20.2	8.2	15.2	7.9

Records of occurrence.—Specimens examined, 71, distributed as follows: SAGUACHE COUNTY: Moffat, 7568 ft., 1 (WC); Crestone, 9 (WC); foot of Madenos [Medano] Pass, 9300 ft., 2 (WC); *Madenos Cañon, above Herard's, 8700 ft.,* 1 (WC). ALAMOSA COUNTY: *northeastern Alamosa County,* 3 (FWS); *24 mi. E Hooper,* 5 (2 AMNH, 3 DMNH); Medano Ranch, 15 mi. NE Mosca, 17 (16 WC, 1 USNM); *3/4 mi. E Headquarters, Great Sand Dunes National Monument,* 1 (KU); *S end Sand Dunes,* 1 (DMNH); *3 1/2 mi. S Great Sand Dunes National Monument,* 1 (KU); 2 mi. NW Mosca, 2 (KU); 22 mi. E Mosca, 3 (AMNH); *1/2 mi. S Uracca [Verracca] Pioneer Cemetery,* 6 (KU); Alamosa, 3 (2 FWS, 1 UMMZ); *1 2/10 mi. E Alamosa,* 1 (KU); *1 mi. E Alamosa,* 3 (KU). COSTILLA COUNTY: Blanca, 1 (WC); Trinchera River, 10 mi. E Fort Garland, 1 (CSU); *2 1/2 mi. SSW Fort Garland,* 1 (AMNH); 5 mi. S Fort Garland, 1 (AMNH); San Acacio, 8 (WC); *2 1/2 mi. SW San Acacio,* 1 (WC); *2 1/2 mi. S San Acacio,* 1 (CSU); Culebra Cañon, 8950 ft., 1 (WC).

Additional records: SAGUACHE COUNTY: 12 mi. NW Saguache (V. Bailey, 1915:106). COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:282).

Thomomys talpoides attenuatus
Hall and Montague

Thomomys talpoides attenuatus Hall and Montague, Univ. Kansas Publ., Mus. Nat. Hist., 5:29, 28 February 1951; type locality, 3 1/2 mi. W Horse Creek Post Office, 7000 ft., Laramie Co., Wyoming.

Distribution in Colorado.—High Plains and immediately adjacent Colorado Piedmont, South Platte drainage (Fig. 55).

Comparisons.—From *T. t. cheyennensis,* a subspecies that occurs in Nebraska and southeastern Wyoming, *T. t. attenuatus* differs in smaller external and cranial size and relatively more slender skull. From *T. t. rostralis,* the subspecies of the Front Range and adjacent areas, *T. t. attenuatus* differs in smaller external and cranial size, and paler (more grayish, less brownish) color.

Measurements.—External measurements of a male and mean (and extremes) of four females from northwestern Logan County are: 215, 198.2 (184-213); 59, 54.5 (48-69); 29, 26.5 (26-27). Cranial measurements are presented in table 14.

Remarks.—Hall and Montague (1951:30) noted that specimens from [10 mi. NE] Avalo were typical of *attenuatus,* but that a specimen from Pawnee Buttes was larger than typical *attenuatus* and ". . . suggests intergradation with the subspecies to the southward *[retrorsus],* for example, at Flagler, Colorado." I suspect that this specimen and those seen from Logan County are, in fact, intergrades with *cheyennensis.* The latter specimens are slightly paler in color than topotypes of *attenuatus,* and less yellowish than *cheyennensis* (as known to me by specimens from the vicinity of Pine Bluffs, Wyoming). In external and cranial size, the specimens also are intermediate, but closer to the smaller *attenuatus,* to which subspecies they are referred.

Records of occurrence.—Specimens examined, 27, distributed as follows: LARIMER COUNTY: Goodwin Ranch, 25 mi. N Fort Collins, 4 (CSU). WELD COUNTY: Pawnee Buttes, 5300 ft., 1 (USNM); *23 mi. NE Fort Collins, 5300 ft.,* 3 (CU); Horsetail Creek, 17 mi. NW Stoneham, 3 (DMNH); Geary Reservoir, 3 (DMNH); Nunn, 1 (FWS). LOGAN COUNTY: *Chimney Cañon, 10 mi. NE Avalo, 5100 ft.,* 5 (USNM); *1 1/2 mi. S, 13 mi. W Peetz,* 1 (KU); *sec. 13 or 8, T. 11 N, R. 53 or 54 W,* 1 (KU); 2 1/2 mi. S, 12 mi. W Peetz, 5 (KU).

Thomomys talpoides durranti Kelson

Thomomys talpoides durranti Kelson, Proc. Biol. Soc. Washington, 62:143, 23 August 1949; type locality, Johnson Creek, 14 mi. N Blanding, 7500 ft., San Juan Co., Utah.

Distribution in Colorado.—Presently known only from western end of Roan Plateau (Fig. 55).

Comparisons.—From both *T. t. fossor* and *T. t. meritus,* the subspecies to the south and east, respectively, *T. t. durranti* differs in paler color and in generally broader, more angular skull (also see Durrant, 1952:172).

Measurements.—Mean (and extreme) external measurements of four females from western Garfield County are: 216.2 (210-220), 69.2 (67-72), 27.8 (27-29). External measurements of three males and three females from 22 mi. SW of Meeker are, respectively: 221, 192, 195, 203, 205, 199; 61, 56, 57, 70, 61, 50; 28, 27, 27, 24, 24, 26; 8, 8, 6, 7, 8, 6. Selected cranial measurements are presented in table 14.

Remarks.—I have not examined topotypes of *T. t. durranti* from Utah, but Coloradan specimens herein assigned to that subspecies agree well with the description given by Durrant (1952:172). Compared with specimens from elsewhere in western Colorado, available material differs markedly in color, frequently approaching that of *rostralis* of the Eastern Slope.

A series of *T. talpoides* from a place 22 mi. SW of Meeker may represent an unnamed race. These specimens are similar to *T. t. attenuatus* from southeastern Wyoming in color and size. With respect to named kinds in northwestern Colorado, they are more brownish (less grayish buff) than *ocius,* and markedly larger than specimens of that race. The animals are considerably paler in color than *meritus,* and tend to be slightly smaller, judging from available material. They resemble *durranti* in cranial conformation and size and are herein referred to that subspecies, although they differ from other Coloradan specimens of *durranti* in their slightly paler color with less pronounced orangish-buffy wash.

Limits of the range of *durranti* in Colorado are unknown; probably the subspecies occurs widely over the Roan Plateau and throughout the drainages of Douglas and Piceance creeks. Grand Hogback appears to mark the boundary between *durranti* and *meritus.* In Utah, the subspecies *durranti* is polytopic; the distribution is bisected by the valley of the Colorado River and the range of *Thomomys bottae howelli.* The name *durranti* is applied also to northern pocket gophers of the La Sal and Abajo Mountains of eastern Utah. I have seen no specimens of *durranti* from extreme western Montrose County, Colorado, where it is to be expected.

Records of occurrence.—Specimens examined, 42, distributed as follows: RIO BLANCO COUNTY: 22 mi. SW Meeker, 6200 ft., 10 (TCWC); West Fork Douglas Creek, 35 mi. S Rangely, 8000 ft., 4 (CM). GARFIELD COUNTY: 28 mi. N, 5 mi. W Mack, 7250 ft., 24 (KU); 1 mi. S Rulison, 5200 ft., 4 (MVZ).

Additional record: GARFIELD COUNTY: *Baxter Pass* (V. Bailey, 1915:112, as *fossor*).

Thomomys talpoides fossor J. A. Allen

Thomomys fossor J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:51, 28 April 1893; type locality, Florida, 7200 ft., La Plata Co., Colorado.

Thomomys talpoides fossor, Goldman, Jour. Mamm., 20:234, 15 May 1939.

Distribution in Colorado.—West-central and southwestern parts of state at higher elevations (Fig. 55).

Comparisons. — From *T. t. rostralis,* the subspecies of the Front Range, *T. t. fossor* differs in slightly smaller average cranial size (especially zygomatic breadth, rostral length, and mastoid breadth) and richer, more reddish brown (less grayish brown) color. From *T. t. meritus,* the subspecies to the north in Colorado, *T. t. fossor* differs in slightly larger external and cranial size and more reddish brown color, the underparts tending to be rich orangish buff rather than silvery to pale buff.

Measurements.—Mean (and extreme) external measurements of five males, followed by those of five females, all from the Grand Mesa, Mesa County, are: 230.8 (224-236), 210.4 (201-218); 72.0 (62-80), 69.4 (60-75); 29.0 (28-30), 27.6 (25-29). Average (and extreme) external measurements of nine females from Black Mesa, Gunnison County, are: 211.4 (200-225), 71.1 (62-79), 27.4 (27-28). External measurements of two males and two females from western Montrose County are, respectively: 231, 234, 224, 234; 68, 70, 68, 72; 29, 30, 27, 28. For cranial measurements, see table 14.

Remarks.—Specimens from the Grand Mesa differ from animals from the West Elk and San Juan mountains in being slightly paler in color; no consistent cranial differences were noted. Thaeler (1968:174) pointed out karyological differences within the population currently known as *T. t. fossor*. The diploid number of chromosomes of individuals from the Grand Mesa was found to be 56, and that of animals from San Juan County, 60.

Records of occurrence.—Specimens examined, 231, distributed as follows: GARFIELD COUNTY: Middle Mamm Creek, near Rifle, 9 (WC); 12 mi. SE Rifle, 3 (FMNH). MESA COUNTY: 4 mi. S, 3 mi. E Collbran, 6800 ft., 1 (KU); Grand Mesa, 28 mi. E Grand Junction, 21 (KU); *Grand Mesa,* 3 (1 CSC, 2 CSU); 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft., 5 (KU); *9 mi. S Glade Park,* 5 (2 AMNH, 3 CM); Piñon Mesa, 3 (FMNH). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 10,200 ft., 2 (KU); *1/2 mi. S, 8 mi. E Skyway,* 2 (KU); *3/4 mi. S, 8 mi. E Skyway,* 2 (KU); 1 1/2 mi. S, 8 mi. E Skyway, 2 (KU); 10 mi. S Grand Mesa, 9300 ft., 1 (CSU). GUNNISON COUNTY: 1/8 mi. N Marble, 8000 ft., 1 (KU); *Marble,* 1 (DMNH); Gothic, 9500 ft., 13 (2 AMNH, 1 ANSP, 2 CU, 2 KU, 6 UNM); *7 mi. N Crested Butte, 9500 ft.,* 1 (KU); *1 mi. W Crested Butte,* 1 (WC); *Decker's Ranch, Crested Butte,* 1 (AMNH); Crested Butte, 7 (1 MCZ, 6 WC); *Middle Brush Creek, 9750 ft.,* 2 (WC); West Muddy Creek, sec. 20, T. 12 S, R. 89 W, 1 (WC); 2 mi. S, 9 mi. E Crested Butte, 2 (KU); *Forest Reserve Camp, sec. 7, T. 49 N, R. 4 W,* 9 (1 AMNH, 8 WC); *Black Mesa,* 41 (1 CSU, 40 KU); Black Mesa Experimental Range, 17 (KU); 10 mi. SSE Gunnison, 8600 ft., 1 (FWS); *no locality other than county,* 1 (WSC). MONTROSE COUNTY: Black Canyon of the Gunnison National Monument, 1 (CU); 10 mi. W Montrose, 6900 ft., 11 (KU); SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft., 2 (KU). OURAY COUNTY: Red Mountain, 11,000 ft., 2 (AMNH). SAN MIGUEL COUNTY: *Goat Creek, Lone Cone Peak,* 1 (SC). SAGUACHE COUNTY: 1 1/2 mi. W Cochetopa Pass, 3 (SC); *5 mi. N, 22 mi. W Saguache, 10,000 ft.,* 1 (KU). DOLORES COUNTY: Lone Cone Peak, 6 (SC). HINSDALE COUNTY: Slumgullion Pass, 10 mi. E Lake City, 1 (KU). MINERAL COUNTY: Wasson Ranch, 3 mi. E Creede, 3 (KU). RIO GRANDE COUNTY: Blowout Pass, 11,500 ft. [T. 37 N, R. 5 E], 4 (UI); Comstock Campground, 8 mi. S, 11 mi. W Monte Vista, 1 (UI); 8 mi. S Monte Vista, 5 (UI). LA PLATA COUNTY: 21 mi. N Bayfield, 1 (AMNH); Florida, 4 (AMNH). ARCHULETA COUNTY: Gordon Creek, near junction with Piedra River, 3 (UNM); Devil's Creek, near Dyke, 1 (DMNH); *Navajo River,* 3 (DMNH); Chromo, 3 (DMNH). CONEJOS COUNTY: Platoro, 2 (FHSC); *1 mi. SW Platoro,* 1 (FHSC); 16 mi. SW Alamosa, 1 (ASC); *5 mi. S, 25 mi. W Antonito, 9600 ft.,* 1 (KU); *5 mi. S, 24 mi. W Antonito, 9600 ft.,* 5 (KU); Osier, 1 (DMNH). County unknown: *Jackson Ranger Station, Uncompahgre National Forest,* 4 (SC).

Additional records: GUNNISON COUNTY: *road to Schofield Pass, 11,000 ft.* (Warren, 1937:474); *3 mi. above Gothic* (Warren, *loc. cit.*); confluence of Dry Gulch and Gunnison River, 7350 ft. (Durrant and Robinson, 1962:249); for detailed notes on local distribution near Gothic, see Findley and Negus (1953:238). SAN JUAN COUNTY: 8 mi. W Silverton (Thaeler, 1968:173); Silverton (V. Bailey, 1915: 112). ARCHULETA COUNTY: Pagosa Springs (V. Bailey, *loc. cit.*).

Thomomys talpoides macrotis F. W. Miller

Thomomys talpoides macrotis F. W. Miller, Proc. Colorado Mus. Nat. Hist., 9:41, 14 December 1930; type locality, D'Arcy Ranch, 2 mi. N Parker, about 5700 ft., Douglas Co., Colorado.

Distribution in Colorado.—Known only from the vicinity of the type locality (Fig. 55).

Comparisons.—From *T. t. retrorsus,* the subspecies of the Platte-Arkansas Divide to the south, *T. t. macrotis* differs in overall larger size. From *T. t. rostralis,* the subspecies of the Front Range to the west, *T. t. macrotis* differs in generally larger external and cranial size, and in markedly paler (grayish buff rather than reddish to grayish brown) color.

Measurements.—External measurements of three males and the mean (and extremes) of four females, all from the type locality, are: 240, 227, 227, 227.7 (225-230); 60, 56, 54, 55.6 (53-60); 32, 29, 31, 28.2 (27-32). Selected cranial measurements are presented in table 14.

Remarks.—F. W. Miller (1930d) characterized *T. t. macrotis* as large and dark. To my eye, specimens from the type locality are indistinguishable in color from animals from along the Platte-Arkansas Divide immediately to the south, but the available material of *macrotis* is consistently larger (especially cranially) than are specimens of *retrorsus.* However, further collecting may demonstrate that the names *macrotis* and *retrorsus* refer to a single continuous population, for which the name *macrotis* would have priority.

Records of occurrence.—Specimens examined, 28, distributed as follows: ARAPAHOE COUNTY: 4 mi. N, 10 mi. E Parker, 1 (KU). DOUGLAS COUNTY: D'Arcy Ranch [Rose Ranch], Cherry Creek, 2 mi. N Parker, 26 (1 AMNH, 20 DMNH, 4 KU, 1 USNM); *3 mi. SE Parker,* 2 (DMNH).

Thomomys talpoides meritus Hall

Thomomys talpoides meritus Hall, Univ. Kansas Publ., Mus. Nat. Hist., 5:221, 15 December 1951;

type locality, 8 mi. N, 19 1/2 mi. E Savery, 8800 ft., Carbon Co., Wyoming.

Distribution in Colorado.—Elkhead Mountains, Park Range, Gore Range, White River Plateau; limits of range unknown (Fig. 55).

Comparisons.—From *T. t. rostralis,* a subspecies with a range to the east, *T. t. meritus* differs in smaller external and cranial size and darker color. From *T. t. ocius,* the subspecies of lower elevations in the Yampa River drainage, *T. t. meritus* differs in larger size and markedly darker color. For comparison with *T. t. durranti* and *T. t. fossor,* see accounts of those subspecies.

Measurements.—Mean (and extreme) external measurements of five males from the vicinity of the type locality are: 209.0 (204-215), 58.3 (50-63), 27.4 (25-29), 6.4 (6-7). Mean (and extreme) measurements of four males, followed by those of seven females, all from southern Routt County, are: 218.0 (206-231), 212.3 (203-221); 67.5 (52-79), 61.4 (52-71); 27.0 (25-29), 26.4 (23-27); 8.2 (7-9), 7.7 (7-9); mean weight of four males, 111.18 (102.6-126.0), of four females, 99.55 (90.0-110.7). Average (and extreme) external measurements of seven females from the vicinity of Buford, Rio Blanco County, are: 208.6 (200-230); 58.1 (43-65), 27.7 (27-30). External measurements of three males and the mean (and extremes) of four females, all from eastern Garfield County, are: 222, 223, 223, 214.5 (208-222); 70, 70, 78, 68.8 (65-73); 27, 29, 27, 25.8 (24-27). Selected cranial measurements are presented in table 14.

Remarks.—Specimens from the White River Plateau, eastern Rio Blanco and Garfield counties, agree well with topotypes of *meritus,* but are slightly less reddish in color dorsally. There is a pronounced tendency toward dappling of the head and shoulders with white in available material from the White River Plateau. Spotting is not uncommon in Coloradan populations of *T. talpoides,* but seemingly is particularly frequent in *meritus.*

Records of occurrence.—Specimens examined, 186, distributed as follows: MOFFAT COUNTY: 8 mi. NE Craig, 2 (CM); *8 mi. ENE Craig,* 2 (CM). ROUTT COUNTY: Elkhead Mountains, 20 mi. SE Slater, 1 (USNM); Steamboat Springs, 1 (WC); Rabbit Ears Pass, 9860 ft., 1 (CM); Toponas Creek Campground, sec. 4, T. 1 N, R. 83 W, 9150 ft., 18 (NMSU); Dome Peak, Middle Stillwater Creek, 2 (DMNH); *no locality other than county,* 1 (DMNH). JACKSON COUNTY: near Pearl, 2 (CSU); Mount Zirkel, 10,700 ft., 2 (WC); *Ute Pass camp, Mount Zirkel,* 1 (WC); Buffalo Pass, 10,380 ft., 2 (WC); *Grizzly Peak [N of] Rabbit Ears Pass,* 1 (CSU); *2 mi. N, 2 mi. E Gould, 8600 ft.,* 1 (KU); 3 mi. below Cameron Pass, 1 (WC); *2 mi. N Willow Creek Pass,* 2 (UNM); Willow Creek Pass, 9200 ft., 1 (WC). RIO BLANCO COUNTY: 7 mi. NE Meeker, 6 (CM); *6 mi. NE Meeker,* 2 (CM); 5 mi. S Pagoda Peak, 9100 ft., 11 (KU); *9 1/2 mi. SW Pagoda Peak, 7700 ft.,* 3 (KU); *Lost Creek, 9 mi. NE Buford,* 4 (CM); *Big Beaver Creek, 6800 ft.,* 3 (WC); Ute Creek, 8000 ft., 9 (AMNH); Dry Fork, White River, 6300 ft., 11 (AMNH); *Dry Fork, White River, 6200 ft.,* 9 (AMNH); South Fork, White River, 7000 ft., 2 (AMNH); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 7 (CM); *15 mi. SE Meeker,* 5 (CM); *Compass Creek, 9000 ft.* (not found), 7 (AMNH). GARFIELD COUNTY: *20 mi. SW Toponas,* 18 (DMNH); *1 mi. NW Trappers Lake,* 3 (CM); Trappers Lake, 2 (KU); Mud Spring, 8850 ft. [county line, due N Silt], 2 (WC); 1 mi. S Deep Lake, 36 (KU); West Fork Elk Creek, 8 mi. above New Castle, 7200 ft., 2 (WC). EAGLE COUNTY: near McCoy, 6500 ft., 2 (WC); Allenton, 1 (WC).

Additional records: ROUTT COUNTY: Hahn's Peak (V. Bailey, 1915:112, as *fossor*); Hayden (Bailey, *loc. cit.,* as *fossor*); *6 mi. E Toponas* (Thaeler, 1968:173). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53).

Thomomys talpoides ocius Merriam

Thomomys clusius ocius Merriam, Proc. Biol. Soc. Washington, 14:114, 19 July 1901; type locality, Smith's Fork, 4 mi. SE Fort Bridger, Unita Co., Wyoming.

Thomomys talpoides ocius, Durrant, Univ. Kansas Publ., Mus. Nat. Hist., 1:17, 15 August 1946.

Distribution in Colorado.—Northwestern part of state, generally north of White River and west of Fortification Creek (Fig. 55).

Comparisons.—*Thomomys t. ocius* is readily distinguished from other pocket gophers in Colorado by its small external and cranial size and markedly pale, yellowish to grayish buff, color.

Measurements.—External measurements of a male and a female from Sunbeam, Moffat County, are: 192, 179; 60, 47; 24, 24. External measurements of two females from Craig are: 178, 195; 43, 55; 25, 27. Selected cranial measurements are presented in table 14.

Remarks.—Intergradation between *T. t. ocius* and other named kinds of pocket gophers does not occur in Colorado. For comments on relationships of *ocius* and other taxa in Wyoming, see Long (1965:603) and Thaeler (1968:180).

No specimens of *T. talpoides* are available from west of the Green River in Moffat County. *T. t. ravus,* the subspecies of the Uinta Mountains in Utah, might be expected to occur there (see Durrant, 1952:158).

Records of occurrence.—Specimens examined, 23, distributed as follows: MOFFAT COUNTY: Beaver Creek, 7 mi. NW Ladore, 6000 ft., 4 (CM); Two Bar Springs [20 mi. NW junction Little Snake and Yampa rivers], 3 (DMNH); *[Little] Snake River,* 4 (DMNH); 2 mi. SE Greystone, 1 (CM); Sunbeam, 3 (CSU); Pot Creek, near Pat's Hole, 1 (DMNH); Bear [Yampa] River at Sand Creek, 1 (WC); Craig, 5 (WC). RIO BLANCO COUNTY: 5 mi. W Rangely, 5600 ft., 1 (USNM).

Additional records: MOFFAT COUNTY: 20 mi. W Bagg's Crossing (Warren, 1942:162); [Little] Snake River, 15 mi. NE Sunny Peak (Cary, 1911:134); *Ladore* (V. Bailey, 1915:108); *Douglas Spring, N base Escalante Hills* (Cary, 1911:134). RIO BLANCO COUNTY: *Rangely* (V. Bailey, 1915:108).

Thomomys talpoides retrorsus Hall

Thomomys talpoides retrorsus Hall, Univ. Kansas Publ., Mus. Nat. Hist., 5:83, 1 October 1951; type locality, Flagler, Kit Carson Co., Colorado.

Distribution in Colorado.—Platte-Arkansas Divide, from vicinity of Colorado Springs eastward to vicinity of Seibert (Fig. 55).

Comparisons.—From *T. t. rostralis,* the subspecies of the Front Range, *T. t. retrorsus* differs in generally smaller external and cranial size and paler color. For comparison with *T. t. macrotis,* see account of that subspecies.

Measurements.—External measurements of two males and the mean (and extremes) of six females, all from the immediate vicinity of Colorado Springs, are: 210, 193, 192.7 (186-202); 58, 47, 55.5 (50-62); 28, 28, 26.8 (26-29). Selected cranial measurements are presented in table 14.

Remarks.—Specimens from Divide and near Cascade, Teller County, agree well with *retrorsus* from Colorado Springs, and are tentatively referred to that subspecies. Available material from other localities in the Rampart Range is referable to *rostralis.*

Records of occurrence.—Specimens examined, 39, distributed as follows: ELBERT COUNTY: near head of Beaver Creek, 8 mi. NE Agate, 1 (DMNH); Bijou Creek, near El Paso County line, 3 (DMNH). KIT CARSON COUNTY: Flagler, 1 (USNM). TELLER COUNTY: Divide, 9200 ft., 2 (WC); *5 mi. W Cascade,* 1 (UMMZ); *no locality other than county,* 2 (UMMZ). EL PASO COUNTY: 2 mi. W Ramah, 1 (KU); 5 mi. E Peyton, 2 (KU); 13 mi. N Colorado Springs, 1 (UMMZ); *6 3/10 mi. N Colorado Springs,* 5 (KU); *3 mi. N Colorado Springs,* 2 (WC); *2 mi. N Colorado Springs,* 4 (WC); Colorado Springs, 8 (3 AMNH, 2 CSU, 2 MCZ, 1 WC); *near Colorado Springs,* 2 (WC); *E of Colorado Springs,* 1 (WC); 20 mi. E Colorado Springs, 2 (UMMZ); Colorado City, 1 (MCZ).

Additional records: LINCOLN COUNTY: Limon (Cary, 1911:133). KIT CARSON COUNTY: 8 mi. S Seibert (Hall, 1951a:85). EL PASO COUNTY: Monument (Warren, 1937:473).

Thomomys talpoides rostralis Hall and Montague

Thomomys talpoides rostralis Hall and Montague, Univ. Kansas Publ., Mus. Nat. Hist., 5:27, 28 February 1951; type locality, 1 mi. E Laramie, 7164 ft., Albany Co., Wyoming.

Distribution in Colorado.—Mountainous areas of Eastern Slope (Fig. 55).

Comparisons.—For comparison with adjacent subspecies, see accounts of those taxa.

Measurements.—Mean (and extreme) external measurements of five males, followed by those of eight females, all from within 3 miles of Laramie, Albany Co., Wyoming, are: 219.0 (211-228), 216.0 (198-230); 61.2 (56-70), 58.4 (48-72); 28.0 (27-30), 27.0 (26-28); 7.0 (6-8), 6.6 (5-8); weight, 130.76 (114.0-145.3), 124.39 (106.2-139.0). Average (and extreme) external measurements of 25 males, followed by those of 21 females, all from 1 mi. N Livermore, Larimer County, are: 226.9 (211-244), 228.7 (210-255); 69.6 (58-79), 68.3 (60-83); 28.7 (27-31), 28.7 (26-31). Mean (and extreme) external measurements of four males from southwestern Huerfano County are: 234.2 (228-249), 70.5 (51-89), 29.2 (28-30). Selected cranial measurements are presented in table 14.

Remarks.—The excellent series of skulls available from the vicinity of Livermore was collected under the auspices of the Colorado Cooperative Pocket Gopher Project. That series allows an appreciation for the considerable range of variation possible within a single local population.

Over the extensive range herein ascribed to *T. t. rostralis,* considerable variation in color is apparent. Specimens from the vicinity of Livermore are nearly as pale as specimens of *attenuatus*, although on the basis of large size they clearly represent *rostralis*. Along the Front Range, populations tend to be grayish brown, with reddish brown pelage seen in some individuals from higher elevations. Farther south, in Lake and Chaffee counties, and on the eastern slope of the Sangre de Cristo Range, there is a tendency for a dark grayish to blackish patch.

Specimens are not available from either North Park or Middle Park. Cary (1911:133) thought pocket gophers scarce in North Park, and that has been my experience in the area south of Walden. On geographic grounds, pocket gophers of North Park, Middle Park, and also along the Roaring Fork in Pitkin County would be expected to represent *T. t. meritus*.

Records of occurrence.—Specimens examined, 448, distributed as follows: LARIMER COUNTY: 3 mi. N Virginia Dale, 1 (CSU); *Virginia Dale*, 3 (CSU); *sec. 15, T. 10 N, R. 70 W, 4 mi. NNE Livermore*, 9 (KU); *3 mi. N Owl Canyon*, 3 (KU); *25 mi. NW Fort Collins*, 1 (CSU); *1 mi. N Livermore*, 221 (2 CSU, 1 CU, 218 KU); *1 mi. N, 3/4 mi. E Livermore*, 2 (CSU); *3 mi. W Forks [Hotel, present-day Livermore Post Office], 6000 ft.*, 2 (WC); Parvin Lake, 1 (KU); *24 mi. NW Fort Collins*, 4 (CSU); *1 mi. W Livermore*, 8 (CU); *near Livermore*, 1 (CU); *Livermore*, 3 (CU); *17 mi. NNW Fort Collins*, 1 (CU); *3 1/2 mi. N Waverly*, 2 (KU); *23 mi. NW Fort Collins, 5800 ft.*, 6 (CU); *22 mi. NW Fort Collins*, 1 (CSU); *Log Cabin*, 1 (CSU); *Owl Canyon, 4 mi. N [S?] Livermore*, 5 (KU); *10 mi. N Fort Collins*, 1 (CSU); *21 mi. N Fort Collins*, 4 (CSU); *Elkhorn P. O. [about 1 mi. E present-day Elkhorn School]*, 2 (CSU); *17 1/2 mi. NW Fort Collins*, 2 (CU); Waverly, 4 (CSU); Rawah Primitive Area, 10,500 ft., 1 (CSU); *Bennett Creek*, 2 (CSU); *Rist Canyon, 8 mi. W Bellvue*, 5 (KU); *Buckhorn Ranger Station*, 3 (KU); *8 mi. W Bellvue*, 3 (1 CSU, 2 CU); *Horsetooth Mountain*, 2 (CSU); Spring Canyon, 8 mi. SW Fort Collins, 1 (CSU); *8 mi. N, 11 mi. W Estes Park*, 3 (UI); *Willow Park*, 1 (UMMZ); *1 1/2 mi. N, 4 mi. W Estes Park*, 1 (KU); *Hidden Valley*, 1 (RMNP); *Rock Cabins, Trail Ridge Road*, 1 (RMNP); Estes Park, 3 (CSU); *Hallowell Park*, 1 (RMNP); *3 mi. S, 3 mi. W Estes Park, 8000 ft.*, 2 (UI); *Mill Creek*, 1 (RMNP); *4 mi. S, 3 mi. W Estes Park*, 1 (UI); *4 mi. S, 2 mi. W Estes Park*, 2 (KU); 8 1/2 mi. S Estes Park, 1 (CU). GRAND COUNTY: Cache River, 4 mi. N Stillwater, 1 (UI). SUMMIT COUNTY: no locality other than county, 11,500 ft., 1 (SC). BOULDER COUNTY: Mont Alto Park, 2 mi. W Gold Hill, 8500 ft., 1 (CU); Science Lodge, 2 (CU); *Niwot Ridge*, 1 (CU); *3 mi. S Ward*, 9 (KU); Boulder, 1 (ANSP); *Gregory Canyon*, 1 (CU); *Boulder Canyon*, 1 (CU); Nederland, 4 (FMNH); *Long Canyon, Green Mountain*, 1 (CU); *3 3/10 mi. W Marshall*, 1 (KU); *no locality other than county*, 5 (DMNH). GILPIN COUNTY: Dory Hill Pond, Blackhawk, 2 (ANSP). CLEAR CREEK COUNTY: Loveland Pass, 2 (FWS); Echo Lake, 1 (FMNH); *headwaters, Clear Creek*, 5 (SC); *Hermann Gulch* (not found), 2 (SC); *Cone Peak, 10,300 ft.* (not found), 1 (SC). JEFFERSON COUNTY: Rocky Flats, 1 (CU); *Golden*, 2 (DMNH); Evergreen, 7 (DMNH); *6 mi. SW Evergreen*, 1 (CU); Brook Forest, 3 (SC); Dawson Station, 2 (CSU). DENVER COUNTY: Denver, 4 (FWS). ARAPAHOE COUNTY: 1 mi. S Denver, 2 (FWS). PITKIN COUNTY: Independence Pass, 1 (FMNH). LAKE COUNTY: 8 mi. SW Leadville, 10,000 ft., 2 (KU); 6 mi. W Twin Lakes, 1 (KU). PARK COUNTY: 2 1/2 mi. S Estabrook, 1 (FHSC); Jefferson, 2 (DMNH); Montgomery, 3 (MCZ); *1 mi. above Alma, 10,500 ft.*, 3 (WC); 3 mi. SW Fairplay, 1 (UI); *14 mi. S Fairplay*, 1 (KU); 10 mi. N Antero Junction, 1 (KU). CHAFFEE COUNTY: Colorado Reformatory, Buena Vista, 1 (KU); *2 mi. SE Buena Vista*, 1 (KU); 9 mi. NNW Salida, 4 (KU); 13 mi. NW Salida, 1 (KU); *11 mi. NW Salida*, 1 (KU); near Poncha Pass, 8750 ft., 1 (WC). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 5 (1 CSU, 4 FWS); Cripple Creek, 1 (UNM); *1 mi. E Cripple Creek*, 2 (UNM); *no locality other than county*, 1 (MCZ). EL PASO COUNTY: 4 mi. above Manitou, 1 (WC). FREMONT COUNTY: 1/2 mi. S Coaldale, 1 (FMNH). CUSTER COUNTY: 9 mi. ENE Silver Cliff, 1 (KU); 5 mi. SW Wetmore, 2 (KU); *7 mi. above Wetmore*, 1 (WC); Querida, 9000 ft., 2 (WC); *1 mi. E Querida*, 1 (KU). HUERFANO COUNTY: 15 mi. NW Gardner, 1 (KU); *Muddy Creek*, 1 (WC); *6 mi. W Redwing*, 1 (KU); *5 mi. N La Veta Pass*, 1 (KU); 5 mi. WSW Redwing, 2 (KU); La Veta Pass, 4 (3 AMNH, 1 CSU); La Veta, 2 (CSU); *6 mi. SSE La Veta*, 1 (KU); 5 mi. S, 1 mi. W Cucharas Camps, 7 (KU).

Additional records: JACKSON COUNTY: sand hills E of Canadian Creek (Cary, 1911:133, as *fossor*). GRAND COUNTY: Coulter (V. Bailey, 1915: 112, as *fossor*). PARK COUNTY: *Como* (Bailey, *loc. cit.*, as *fossor*); *Mount Lincoln* (Blake and Blake, 1969:36). HUERFANO COUNTY: *Blue Lake* (Warren, 1935a, as *fossor*).

Geomys bursarius

Plains Pocket Gopher

The range of *Geomys bursarius* is essentially co-extensive with the central North American grassland. In eastern Colorado the species is found at its western limit at that latitude. The animals occur in valleys of major streams and other areas of sandy soils. Areas of heavier soils in east-central Colorado are occupied by *Thomomys talpoides*, and *Pappogeomys castanops* occurs on such soils in the southeastern part of the state. For notes on habitat preferences and ecological relationships among Coloradan pocket gophers, see R. S. Miller (1964).

Where deep sandy soils are present, plains pocket gophers may be abundant, and in some situations, such as irrigated alfalfa lands, may be a considerable nuisance. In addition to feeding on the alfalfa, their burrows may undermine ditch-banks and mounds of earth may damage machinery.

Geomys bursarius has been the subject of intensive study in Colorado. Myers and Vaughan (1964) discussed food preferences and Vaughan (1966) studied food-handling and grooming behavior. Patterns of activity were discussed by Vaughan and Hansen (1961), Vaughan (1962) investigated reproductive characteristics, and ectoparasites were reported by Miller and Ward (1960).

No study of geographic variation of the plains pocket gopher over its range has been published in recent years. At the present time, R. Laurie Hendricksen of the Museum of Natural History, University of Kansas, is studying variation in *G. bursarius* along a transect from the Missouri River to the Rocky Mountains, generally between the 39th and 40th parallels. In her study, Coloradan populations from Adams and Washington counties are under investigation.

Geomys bursarius jugossicularis Hooper

Geomys lutescens jugossicularis Hooper, Occas. Papers, Mus. Zool., Univ. Michigan, 420:1, 28 June 1940; type locality, Lamar, Prowers Co., Colorado.

Geomys bursarius jugossicularis, Villa-R. and Hall, Univ. Kansas Publ., Mus. Nat. Hist., 1:226, 29 November 1947.

Distribution in Colorado.—In suitable habitat in southeastern part of state, south of Platte-Arkansas Divide (Fig. 56).

Comparison.—From *G. b. lutescens*, the subspecies geographically adjacent to the north, *G. b. jugossicularis* differs in slightly more reddish, less buffy color dorsally, deeper zygomatic plate, and markedly shorter jugal bone.

Measurements.—External measurements of the holotype (UMMZ 56951, a young adult male) and two females from near the type locality are, respectively: 241, 254, 236; 68, 72, 67; 31, 32, 31; 4, —, 3. External measurements of a male and two females from southeastern Baca County are: 255, 243, 255; 87, 82, 83; 31, 32, 32; weights, 215, 178, 175. External measurements of two males, and mean (and extremes) of five females, all from east-central Fremont County, are: 269, 303, 254.6 (249-267); 80, 93, 81.6 (75-90); 32, 36, 32.8 (31-35). Selected cranial measurements are presented in table 15.

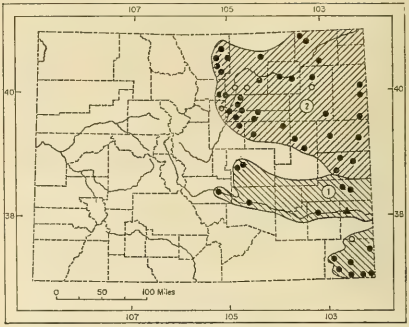


FIG. 56. Distribution of *Geomys bursarius* in Colorado. 1. *G. b. jugossicularis.* 2. *G. b. lutescens.* For explanation of symbols, see p. 9.

Remarks.—Externally, Coloradan specimens of *G. b. lutescens* and *G. b. jugossicularis* are practically indistinguishable, although topotypes of the two races differ consistently, if slightly, in color. The subspecies are remarkably distinct in cranial detail, however. The best criterion by which to distinguish *jugossicularis* is the relatively short jugal bone. The length of the jugal and the length of the zygomatic arch anterior to the jugal (measured from the anteromost point on the jugal to the junction of frontal, maxillary, and premaxillary) were considered. The mean ratio of these two measurements in a sample of *G. bursarius* from south of the Arkansas River was 0.6922 (range, 0.589-0.767) for five males, and 0.6899 (range, 0.536-0.882) for five females. In a sample of individuals from northeastern Colorado (along and north of a line from Denver to Cope), the mean ratio was 0.9681 (range, 0.792-1.030) for nine males, and 0.9231 (range, 0.798-1.090) for 16 females.

Specimens from east-central Fremont County (south-southeast of Cañon City and west of Florence) are the largest individuals

TABLE 15

Selected cranial measurements of two species of Geomyidae.

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital breadth	Mastoid breadth	Breadth of rostrum	Length of nasals	Length of maxillary toothrow
Geomys bursarius jugossicularis, vicinity of Lamar, Prowers County								
UMMZ 56951, ♂	43.7	37.1	27.2	5.7	25.8	11.0	8.4	15.5
KU 15982, ♀	40.0	34.2	24.2	6.1	24.0	9.5	8.0	12.8
KU 98282, ♀	42.0	35.9	26.8	5.9	24.3	10.4	8.4	13.7
southeastern Baca County								
KU 76761, ♂	44.4	38.0	26.4	5.9	23.8	10.2	8.6	16.2
KU 76757, ♀	41.7	35.9	27.0	5.8	25.5	9.6	7.7	14.1
KU 76759, ♀	41.8	35.3	25.0	6.4	24.0	9.9	8.3	14.3
between Cañon City and Florence, east-central Fremont County								
KU 76749, ♂	51.2	45.1	33.5	6.1	27.4	12.7	9.3	19.8
KU 72922, ♂	46.9	40.6	30.0	6.1	25.1	11.2	8.4	17.7
Mean, 5 ♀	43.96	37.38	26.26	5.74	23.88	10.48	8.44	16.28
Minimum	42.2	36.6	25.7	5.6	23.2	10.2	7.9	15.7
Maximum	46.4	38.5	27.5	5.8	24.7	10.8	9.1	17.3
Geomys bursarius lutescens, 8 2/10 mi. E Boulder, Boulder County								
KU 75442, ♀	42.9	37.1	27.3	6.8	24.6	10.7	8.6	16.2
KU 75443, ♀	42.9	36.9	26.6	6.8	24.4	10.3	8.2	16.0
KU 75444, ♀	42.5	36.6	26.4	6.7	24.2	10.2	8.9	—
KU 75446, ♀	42.4	36.7	27.1	6.6	24.3	10.6	8.5	15.9
Cope, Washington County								
KU 74603, ♀	42.5	36.6	27.0	6.6	24.1	10.3	7.9	16.0
KU 74605, ♀	43.0	37.1	26.3	6.5	24.4	10.0	7.5	15.2
2 mi. E Brighton, Adams County								
KU 74574, ♂	45.9	40.0	30.2	6.1	27.3	11.0	8.5	17.6
KU 74578, ♂	47.7	41.5	31.3	6.3	26.9	11.9	8.8	18.6
KU 74585, ♂	47.5	41.5	32.0	6.8	27.8	12.0	9.5	18.4
Mean, 5 ♀	41.48	35.78	26.10	6.58	23.68	10.50	8.32	15.44
Minimum	41.1	35.0	25.4	6.4	23.2	10.3	8.2	15.3
Maximum	42.1	36.4	26.7	6.8	23.8	10.7	8.5	15.7
1/2 mi. WSW Masonville, Larimer County								
KU 70029, ♂	50.1	44.0	32.3	7.3	28.0	12.6	8.6	18.5
KU 70030, ♂	48.6	42.8	31.5	7.1	27.7	11.8	8.8	18.5
KU 70031, ♂	48.0	42.0	32.0	7.1	27.3	11.7	8.2	17.4
Pappogeomys castanops castanops, Las Animas and Baca counties								
Mean, 5 ♂	54.60	47.52	36.73	6.92	30.78	12.60	10.42	20.64
Minimum	52.0	45.5	34.2	6.5	28.9	12.1	10.2	19.0
Maximum	56.4	48.9	38.9	7.4	33.6	13.0	11.0	21.5
Mean, 13 ♀	48.67	42.16	31.18	6.78	27.58	10.29	9.80	17.50
Minimum	46.6	40.3	30.1	6.2	26.6	9.6	9.5	16.8
Maximum	50.2	43.5	32.3	7.2	28.5	10.7	10.9	18.5

of *G. bursarius* examined by me from Colorado; the largest male weighed 328 grams. Specimens from that area may be found to represent an undescribed subspecies. The status of *G. bursarius* in the vicinity of Cañon City is worthy of intensive study, inasmuch as the range of the species is surrounded by that of *Thomomys bottae* in that area. The valley pocket gopher is represented by a distinct local population *(Thomomys bottae rubidus)* in the vicinity of Cañon City that is characterized by large size.

Specimens that are in my judgment certain intergrades between *jugossicularis* and *lutescens* are known only from Kit Carson, Cheyenne County (herein referred to *lutescens*). Hall and Kelson (1952:364) regarded specimens from Las Animas as intergrades between *lutescens* and *jugossicularis* and referred specimens from Pueblo to *lutescens*. Except in the extreme eastern part of the state, along the lower reaches of Big Sandy Creek, genetic contact between the two populations probably is minimal, inasmuch as they are separated by generally unsuitable habitat occupied by *Thomomys talpoides retrorsus*, east as far as western Kit Carson County.

Records of occurrence.—Specimens examined, 68, distributed as follows: 1 1/2 mi. N, 9 mi. E Colorado Springs, 4 (CSU); Colorado Springs, 2 (WC); *3 1/2 mi. SW Colorado Springs*, 2 (KU); *4 mi. SE Colorado Springs*, 1 (KU). FREMONT COUNTY: 4 mi. SSE Cañon City, 5200 ft., 6 (KU); *4 mi. W Florence*, 2 (KU); 3 mi. W Florence, 3 (UU). PUEBLO COUNTY: Pueblo, 5 (1 SCSC, 4 USNM). KIOWA COUNTY: 3 mi. E Eads, 1 (KU); Chivington, 6 (USNM). BENT COUNTY: Las Animas, 11 (1 FWS, 3 SC, 7 USNM). PROWERS COUNTY: Lamar, 4 (2 FWS, 1 UMMZ, 1 WC); *1 mi. S Lamar*, 4 (KU); *2 1/2 mi. S Lamar*, 1 (KU); *3 1/2 mi. S Lamar*, 1 (KU). BACA COUNTY: Monon, 3 (WC); 8 mi. S Pritchett, 1 (KU); 9 8/10 mi. N Campo, 1 (KU); 15 3/10 mi. W Campo, 2 (KU); *3 6/10 mi. W Campo*, 2 (KU); 8 mi. S Campo, 1 (KU); *8 mi. S, 1 6/10 mi. E Campo*, 1 (KU); 8 mi. S, 12 7/10 mi. E Campo, 1 (KU); Regnier, 2 (DMNH); Craugh Ranch, Cimarron River, 1 (DMNH).

Additional record: BACA COUNTY: 14 mi. N, 4 mi. E Springfield (in owl pellet, KU uncatalogued).

Geomys bursarius lutescens Merriam

Geomys bursarius lutescens Merriam, N. Amer. Fauna, 4:51, 8 October 1890; type locality, sandhills on Birdwood Creek, Lincoln Co., Nebraska.

Distribution in Colorado.—Plains of eastern part of state, north of Platte-Arkansas Divide (Fig. 56).

Comparison.—For comparison with *G. b. jugossicularis*, see account of that subspecies.

Measurements.—External measurements of three males and mean (and extremes) of five females, all from western Adams County, are: 262, 275, 270, 243.0 (233-253); 85, 96, 84, 77.8 (74-81); 34, 36, 36, 31.1 (30-33); weight, 273, 280, 252, 181.16 (177.0-188.3). External measurements of four females from 8 2/10 mi. E of Boulder are: 258, 244, 247, 239; 78, 74, 78, 73; 31, 30, 31, 30. Measurements of two females from Cope, Washington County, are: 249, 252; 75, 79; 32, 33. Those of four young adult males from 1/2 mi. WSW Masonville, Larimer County, are: 275, 292, 275, 285; 88, 100, 95, 86; 34, 34, 35, 35. For cranial measurements, see table 15.

Remarks.—Coloradan specimens herein referred to *G. b. lutescens* are (save for an apparently exceptional local population discussed beyond) generally smaller than near topotypes of *lutescens* examined from north and west of Hershey, Lincoln Co., Nebraska.

Four specimens from a place 1/2 mi. WSW of Masonville, Larimer County, are the largest individuals of *lutescens* seen by me (see measurements listed above and table 15). The skins obviously are somewhat stretched, but the individuals are nonetheless remarkably large; although young adult males (April-taken young of the previous year), in external and cranial dimensions they exceed full adults from elsewhere in the range of the subspecies in Colorado. The locality in question is near the western extreme of the range of the subspecies, in the valley of Buckhorn Creek between a prominent hogback ridge and the foothills east of Storm Mountain. Intensive study of a population in such a situation would be of considerable interest. The distinctive character of the above-mentioned specimens suggests microgeographic variation in a local, perhaps semi-isolated, population. The relationship of this population to the main segment of *lutescens* is curiously analogous to the relationship of animals from east-central Fremont County to the conterminous range of *jugossicularis*, as discussed in the account of the latter subspecies.

I doubt the (literal) accuracy of labels on specimens (CSU, uncatalogued) reading "14 mi. W Fort Collins," "13 mi. W Fort Collins," and the like, and do not admit them as marginal records. Probably the mileage given for these specimens was measured by road in Rist, Buckhorn, or perhaps Redstone, canyons.

Records of occurrence.—Specimens examined, 279, distributed as follows: LARIMER COUNTY: 13 2/10 mi. N, 3 6/10 mi. W Fort Collins, 6100 ft., 1 (CU); *2 1/2 mi. N Ted's Place,* 1 (KU); *7 mi. NW Fort Collins,* 1 (CSU); *3 6/10 mi. N Fort Collins,* 1 (CSU); *3 mi. N Fort Collins,* 1 (CSU); *4 mi. NE Fort Collins,* 1 (CSU); *Terry Lake, 1 mi. N Fort Collins,* 4 (1 CSC, 3 CSU); *Laporte,* 9 (CSU); *2 mi. NNW Fort Collins,* 2 (CSU); *2 1/2 mi. NE Fort Collins,* 1 (CSU); *2 mi. NW Fort Collins,* 2 (CSU); *NW edge of Fort Collins,* 1 (CSU); *1 mi. N, 1 mi. W Fort Collins,* 1 (CSU); *Shields Street, N of Fort Collins,* 1 (KU); *7/10 mi. N Fort Collins,* 3 (CSU); *1/4 mi. N Fort Collins,* 1 (CU); *14 mi. W Fort Collins,* 1 (CSU); *13 mi. W Fort Collins,* 6 (CSU); 10 mi. W Fort Collins, 1 (CSU); *8 mi. W Fort Collins,* 2 (CU); *5 mi. W Fort Collins,* 2 (CSU); *4 mi. W Fort Collins,* 1 (CSU); *2 mi. W Fort Collins,* 1 (CSU); *Fort Collins,* 21 (1 CSC, 20 CSU); *1 mi. E Fort Collins,* 1 (CU); *E of Fort Collins,* 1 (CSU); *1 1/2 mi. E Fort Collins,* 5 (KU); *2 mi. E Fort Collins,* 3 (CU); *2 1/2 mi. E Fort Collins,* 1 (CSU); *3 mi. E Fort Collins,* 4 (CSU); *4 mi. E Fort Collins,* 1 (CSU); 5 mi. E Fort Collins, 1 (CSU); *1 mi. S, 3 1/2 mi. E Fort Collins,* 2 (CSU); *2 1/2 mi. SE Fort Collins,* 1 (CSU); *1/4 mi. S Timnath Reservoir,* 2 (CSU); *1 mi. N, 2 mi. E Timnath, 4600 ft.,* 1 (CSU); *3/10 mi. N, 1 mi. E Timnath, 5000 ft.,* 1 (CSU); *1 mi. S Timnath,* 1 (CSU); *6 mi. S, 5 mi. E Fort Collins,* 1 (CSU); *1 mi. NE Masonville,* 2 (CU); *Masonville,* 11 (KU); *1 mi. E Masonville,* 1 (CU); *10 mi. SW Fort Collins,* 1 (CSU); 1/2 mi. WSW Masonville, 4 (KU); *13 mi. SW Fort Collins,* 1 (CSU); *Loveland,* 13 (USNM); Big Thompson River, Loveland, 1 (CU). WELD COUNTY: 1 mi. W Briggsdale, 1 (KU); 9 mi. N Roggen, 3 (DMNH). MORGAN COUNTY: Muir Springs, 2 mi. N, 2 1/2 mi. W Fort Morgan, 11 (KU); 5 mi. S Brush, 1 (UNM). LOGAN COUNTY: Chimney Cañon, 10 mi. NE Avalo, 1 (USNM); *1 1/2 mi. S, 13 mi. W Peetz,* 1 (KU); 20 mi. E Avalo, 2 (USNM); 10 mi. SE Sterling, 2 (USNM). BOULDER COUNTY: *Valmont,* 2 (USNM); Boulder, 1 (ANSP); *8 2/10 mi. E Boulder,* 7 (KU); 9 mi. E Boulder, 1 (KU); *White Rocks, Valmont,* 1 (WC). JEFFERSON COUNTY: Wheatridge, 1 (CU); *Mount Olivet,* 2 (DMNH). ADAMS COUNTY: *3 mi. NE Barr Lake,* 9 (KU); *2 mi. E Brighton,* 14 (KU); Barr, 6 (2 DMNH, 4 WC); *Barr Lake,* 1 (DMNH); 10 mi. NE Denver, 1 (DMNH); *3 mi. NE Fitzsimmons,* 1 (DMNH); *Fitzsimmons Hospital,* 8 (7 DMNH, 1 CU); Platte River at Sand Creek, 1 (DMNH); *1 mi. N, 6 mi. E Denver,* 2 (DMNH); 10 mi. E Denver, 2 (DMNH); *no locality other than county,* 9 (DMNH). DENVER COUNTY: Denver, 31 (5 AMNH, 2 CU, 3 DMNH, 15 FWS, 3 KU, 3 UI). ARAPAHOE COUNTY: Wolf Creek P. O., 1 (WC); *Aurora,* 1 (CU); *Sullivan Dam,* 2 (DMNH); Cherry Creek, 3 (DMNH); Wolf Creek, T. 5 S, R. 63 W, 1 (CSU). WASHINGTON COUNTY: *Eastern Colorado Experiment Station, near Akron,* 4 (UNM); 15 mi. N Akron, 1 (CSU); Cope, 11 (KU). YUMA COUNTY: 10 mi. N Wray, 1 (DMNH); *Wray,* 13 (9 DMNH, 4 WC); 7 mi. S Wray, 3 (CU); *Dry Willow Creek,* 1 (DMNH); 1/2 mi. S, 2 mi. W Hale, 2 (KU). DOUGLAS COUNTY: Rose [D'Arcy] Ranch, 2 mi. N Parker, 5 (KU). ELBERT COUNTY: 8 mi. NE Agate, 3 (DMNH); Kiowa, 2 (DMNH). LINCOLN COUNTY: Limon, 3 (USNM); Hugo, 1 (USNM). KIT CARSON COUNTY: Seibert, 1 (USNM); Burlington, 1 (USNM). CHEYENNE COUNTY: near Twin Buttes, 4850 ft., 1 (USNM); 6 mi. N Cheyenne Wells, 1 (WC); Kit Carson, 2 (USNM).

Additional records: WELD COUNTY: 10 mi. S La Salle (Vaughan, 1961b:412); 4 mi. N Hudson (Vaughan and Hansen, 1961:541). WASHINGTON COUNTY: Akron (Hooper, 1940:3).

Pappogeomys castanops

Chestnut-faced Pocket Gopher

The Arkansas Valley in Colorado marks the northern limit of the range of *Pappogeomys castanops,* a species that ranges southward to San Luis Potosí. *Pappogeomys castanops* is the largest of Coloradan pocket gophers and is found most frequently in sandy soils of stream margins, habitat similar to that utilized by *Geomys bursarius. Pappogeomys* also occupies heavier soils on uplands.

Cary (1911:130) reported that C. E. Aiken, a pioneer Colorado Springs taxidermist and naturalist, had mounted a specimen taken ". . . near the reservoirs several miles north of Lamar . . . ." Today, *P. castanops* is not known to occur north of the Arkansas River. R. S. Miller (1964) was of the opinion that *G. bursarius* had expanded its range westward at the expense of *P. castanops,* the latter species being restricted to marginal situations, xeric habitats in less friable soils. If the present situation does represent a change, it apparently is a change in degree. A situation comparable to that seen today has existed between the two species at least since the turn of the century. Cary (1911:129) noted that *G. bursarius* was abundant in sandy soils in the vicinity of Lamar, whereas *P. castanops* was "largely restricted to hard-soil flats." V.

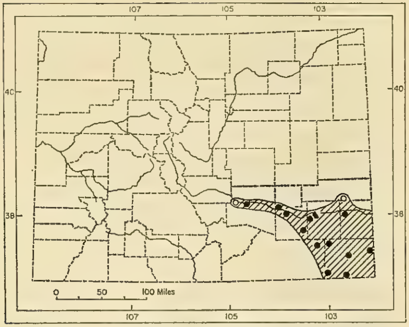


FIG. 57. Distribution of *Pappogeomys castanops castanops* in Colorado. For explanation of symbols, see p. 9.

Bailey (1895:44) noted a similar relationship between the two species at Las Animas. Russell (1968) detailed geographic variation in *P. castanops.*

Pappogeomys castanops castanops (Baird)

Pseudostoma castanops Baird, *in* Stansbury, Exploration and survey of the Valley of the Great Salt Lake of Utah, App. C, p. 313. June 1852; type locality, "along prairie road to Bent's Fort," S of Las Animas, Bent Co., Colorado.

Pappogeomys castanops castanops, Russell, Univ. Kansas Publ., Mus. Nat. Hist., 16:635, 5 August 1968.

Distribution in Colorado.—Plains of southeastern part of state, generally south of Arkansas River (Fig. 57).

Comparison.—From *P. c. perplanus,* the subspecies of the Panhandle of Oklahoma and the Llano Estacado, *P. c. castanops* differs in averaging larger externally and cranially, in having a relatively longer tail and more ochraceous (less buffy) ventral color, and in cranial details (Russell, 1968:651).

Measurements.—Mean (and extreme) external measurements of five males, followed by those of 14 females, all from eastern Las Animas County and adjacent Baca County, are: 280.4 (266-290), 258.4 (247-270); 73.0 (68-78), 70.6 (68-78); 36.8 (35-39), 35.5 (34-37). Selected cranial measurements are presented in table 15.

Records of occurrence.—Specimens examined, 46, distributed as follows: PUEBLO COUNTY: 3 mi. W Pueblo on Buelah Road, 1 (WC). CROWLEY COUNTY: Olney [Springs], 2 (USNM). OTERO COUNTY: 4 mi. W Rocky Ford, 5 (2 CSU, 3 KU); *Colorado Agricultural Experiment Station, Arkansas Valley Branch,* 1 (CSU); JJ Ranch, Higbee, 18 mi. S La Junta, 2 (USNM). BENT COUNTY: *Las Animas,* 6 (USNM); 12 mi. E La Junta, 1 (KU); prairie road to Bent's Fort, 1 (USNM); *14 mi. E La Junta,* 1 (KU). PROWERS COUNTY: 1/2 mi. S Lamar, 1 (WC). LAS ANIMAS COUNTY: Irwin's Ranch, 5000 ft. [T. 29 S, R. 52 W], 7 (WC). BACA COUNTY: Gaume's Ranch, 4600 ft., 2 (WC); Monon, 2 (WC); Bear Creek, N of Springfield, 6 (WC); Furnace [Furnish] Canyon, 9 (DMNH); Regnier, 1 (DMNH).

Additional record: PUEBLO COUNTY: Arkansas River, 26 mi. below Cañon City (Russell, 1968:637).

FAMILY HETEROMYIDAE—POCKET MICE AND KANGAROO RATS

KEY TO SPECIES OF HETEROMYIDAE IN COLORADO

1. Cheekteeth rooted, crown pattern not completely simplified; anterior root of zygomatic arch not greatly enlarged 2

Cheekteeth ever-growing, crown pattern simplified; anterior root of zygomatic arch greatly enlarged 7

2. Fur harsh to the touch; mastoid bullae relatively small, not projecting beyond occiput; occipitonasal length usually 30 or greater .... *Perognathus hispidus*

Fur not harsh to the touch; mastoid bullae relatively large, projecting beyond occiput; occipitonasal length less than 25 3

3. Tail greater than one-half total length; hindfoot greater than 20; antitragus lobed .... **Perognathus parvus*

Tail usually less than one-half total length; hindfoot less than 20; antitragus not lobed 4

4. Fur lax, silky; buffy postauricular patch larger than ear; total length less than 120 .... *Perognathus flavus*

Fur not noticeably lax and silky; postauricular patch smaller than ear or lacking; total length greater than 120 5

5. Auditory bullae meeting anteromedially; dorsal color buffy .... *Perognathus flavescens*

Auditory bullae not meeting anteromedially; dorsal color olivaceous or brownish buff (except in *Perognathus fasciatus callistus*) 6

6. Tail usually less than 60; angular process of mandible as long as condyloid process .... *Perognathus fasciatus*

Tail usually greater than 60; angular process of mandible shorter than condyloid process .... *Perognathus apache*

7. Five toes on hind foot; total length 280 or less; proximal part of tail bicolor .... *Dipodomys ordii*

Four toes on hind foot; total length 300 or more; proximal part of tail black .... **Dipodomys spectabilis*

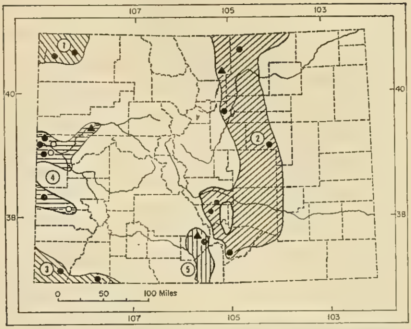


FIG. 58. Distribution of two species of pocket mice in Colorado. 1. *Perognathus fasciatus callistus.* 2. *P. f. infraluteus.* 3. *Perognathus apache apache.* 4. *P. a. caryi.* 5. *P. a. relictus.* For explanation of symbols, see p. 9.

Perognathus fasciatus

OLIVE-BACKED POCKET MOUSE

The olive-backed pocket mouse occurs generally over the northern Great Plains, from southern parts of the Prairie Provinces, southward to south-central Colorado. The natural history of the species never has been thoroughly investigated, and its status in Colorado is poorly understood. The altitudinal range of specimens examined is about 5000 to 7000 feet.

Jones (1953) reviewed the geographic distribution and subspecies of *Perognathus fasciatus.* Hayward and Killpack (1956) noted that *P. fasciatus* and *P. apache* are allopatric in northeastern Utah. A similar relationship between those two species is indicated in south-central Colorado, where they are separated by the Sangre de Cristo Range. *Perognathus fasciatus* is sympatric over a broad area in Colorado with *P. flavescens, P. flavus,* and *P. hispidus.* Relationships of the nominal species *P. fasciatus* and *P. apache* are under study by Mr. D. F. Williams of the Museum of Southwestern Biology, University of New Mexico.

Maxell and Brown (1968) discussed the ecological distribution of *P. fasciatus* in eastern Wyoming. The few individuals captured all were taken in a *Bouteloua-Stipa* community, indicating a predilection for sites with low, closely-spaced vegetation, and a substrate of loamy sand. The pattern of occurrence of such communities in eastern Colorado may influence the apparent scarcity of the olive-backed pocket mouse, and the seeming restriction of the species on the Eastern Slope to a rather narrow band of grassland near the mountain front.

Perognathus fasciatus callistus Osgood

Perognathus callistus Osgood, N. Amer. Fauna, 18:28, 20 September 1900; type locality, Kinney Ranch, near Bitter Creek, Sweetwater Co., Wyoming.

Perognathus fasciatus callistus, Jones, Univ. Kansas Publ., Mus. Nat. Hist., 5:524, 1 August 1953.

Distribution in Colorado.—Known only from north of the Yampa River, Moffat County (Fig. 58).

Comparisons.—From *P. f. infraluteus* and *P. f. olivaceogriseus,* subspecies of the Great Plains, *P. f. callistus* differs in paler color, less olivaceous and less heavily washed with black, and generally larger cranial size (for more detailed comparisons, see Jones, 1953:524).

Measurements.—Mean (and extreme) external measurements of 10 males, followed by measurements of a female, all from Moffat County, are: 130.4 (127-135), 122; 61.9 (55-75), 56; 17.6 (14-19), 18. Selected cranial measurements are given in table 16.

Remarks.—The occurrence of a species of *Perognathus* in northwestern Colorado was suspected for a number of years (see Cary,

TABLE 16

Selected cranial measurements of four species of *Perognathus*.

Number averaged (or catalog number), sex	Occipitonasal length	Zygomatic breadth	Interorbital constriction	Breadth of interparietal	Breadth across bullae	Length of maxillary toothrow	Length of nasals
Perognathus fasciatus callistus, Moffat County							
DMNH 2103, ♂	22.5	10.7	5.1	4.4	13.0	3.4	8.2
DMNH 2227, ♂	21.7	10.8	4.9	—	12.6	3.2	8.1
DMNH 2228, ♂	—	10.9	5.0	4.5	12.8	3.3	—
DMNH 2100, ♀	21.4	—	5.1	4.5	12.5	3.4	8.1
Perognathus fasciatus infraluteus, Loveland, Larimer County							
Mean, 4 ♂	21.55	12.00	4.90	5.02	12.17	3.45	7.82
Minimum	21.1	11.8	4.8	4.8	11.8	3.4	7.5
Maximum	21.9	12.3	5.0	5.3	12.5	3.5	8.2
USNM 69339, ♀	21.1	11.7	4.8	5.1	11.7	3.2	7.5
northwestern Weld County							
CSU 10502, ♀	22.0	11.8	4.9	4.8	—	3.4	7.9
CSU 10534, ♀	21.6	11.6	4.6	4.8	11.5	3.5	8.0
Perognathus apache apache, Montezuma County							
KU 97312, ♀	21.1	11.4	5.2	3.8	11.9	3.3	7.7
Perognathus apache caryi, Bedrock, Montrose County							
WC 2996, ♂	22.9	—	5.0	4.7	12.8	3.5	8.7
WC 3017, ♂	23.0	—	5.5	4.4	12.9	3.3	8.7
Perognathus apache relictus, Medano Ranch, 15 mi. NE Mosca, Alamosa County							
Mean, 6 ♂	22.17	11.74	5.57	3.83	12.38	3.10	8.03
Minimum	21.8	11.4	5.1	3.7	11.7	3.0	7.8
Maximum	22.7	11.9	5.9	4.4	13.1	3.3	8.2
Perognathus flavescens flavescens, northern Washington County							
Mean, 4 ♀	21.40	11.35	5.12	4.88	12.10	3.15	7.90
Minimum	21.0	11.1	4.8	4.7	11.6	3.1	7.5
Maximum	21.8	11.6	5.3	5.0	12.4	3.2	8.3
Mean, 5 ♂	21.35	11.50	4.96	4.74	12.10	3.22	7.67
Minimum	21.1	11.2	4.8	4.6	11.8	3.1	7.6
Maximum	21.6	11.8	5.1	4.9	12.3	3.4	7.7
Perognathus flavus bunkeri, N of Cañon City, Fremont County							
DMNH 3042, ♂	20.9	10.4	4.7	3.9	12.2	3.2	7.0
DMNH 3044, ♂	20.4	10.5	4.7	3.5	11.8	3.1	7.1
Mean, 5 ♀	21.00	10.10	4.64	3.80	11.82	3.24	7.02
Minimum	20.8	9.8	4.6	3.5	11.7	3.2	6.9
Maximum	21.3	10.4	4.7	4.0	12.0	3.3	7.1
Perognathus flavus sanluisi, Alamosa and Costilla counties							
Mean, 6 ♂	19.25	10.91	4.45	3.47	11.84	3.18	7.13
Minimum	18.8	10.5	4.4	3.2	11.6	3.1	6.8
Maximum	20.1	11.3	4.6	3.7	12.1	3.3	7.5
Mean, 4 ♀	19.85	10.73	4.42	3.27	11.72	3.22	7.10
Minimum	19.4	10.5	4.3	3.1	11.5	3.0	7.0
Maximum	20.4	10.9	4.5	3.4	11.9	3.4	7.2

1911:148) before specimens of *P. f. callistus* first were reported by F. W. Miller (1928a).

Records of occurrence.—Specimens examined, 13, distributed as follows: MOFFAT COUNTY: [Little] Snake River, 7 mi. above Bear [Yampa] River, 3 (DMNH); Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 10 (DMNH).

Perognathus fasciatus infraluteus Thomas

Perognathus infraluteus Thomas, Ann. Mag. Nat. Hist., ser. 6, 11:406, May 1893; type locality, Loveland, Larimer Co., Colorado.

Perognathus fasciatus infraluteus, Osgood, N. Amer. Fauna, 18:19, 20 September 1900.

Distribution in Colorado.—Western part of Colorado Piedmont (Fig. 58).

Comparison.—P. f. infraluteus differs from *P. f. olivaceogriseus* in slightly darker color, paler (less ochraceous) lateral line, and slightly smaller cranial size (see Jones, 1953: 520, and also remarks below).

Measurements.—Mean (and extreme) external measurements of four males, followed by measurements of three females, all from the type locality, are: 129.5 (128-131), 128, 125, 124; 60.0 (59-61), 58, 59, 56; 17.2 (17-18), 17, 18, 17. External measurements of two females from Weld County and a female from Jefferson County are: 124, 132, 126; 54, 62, 61; —, 16, 17 (dry); 7, 7, 9; weights, 11.0, 10.0, —. For cranial measurements, see table 16.

Remarks.—The subspecific name best applicable to olive-backed pocket mice in central Colorado has been a matter of some doubt. Jones (1953:523) referred a specimen from Elbert County to *P. f. infraluteus* on geographic grounds, whereas Turner (1968) referred to *olivaceogriseus* a specimen from Huerfano County. To my eye, those two specimens are indistinguishable.

A character supposedly diagnostic of *infraluteus* is the strong buffy suffusion of the hairs of the venter, a continuation of the color of the lateral line. This condition is most marked in specimens from the type locality. Of 10 specimens in the U. S. National Museum, four exhibit a buffy wash over virtually the entire ventral surface. Three specimens show the obvious encroachment of the color of the lateral line on the underparts, but have a prominent white patch in the pectoral region. Three topotypes show little or no tendency toward a buffy suffusion of the venter. Of a series of 14 specimens examined from eastern Wyoming and adjacent Nebraska, three showed traces of a buff tinge on an otherwise white venter. Unfortunately, the relatively large series of specimens from the Wet Mountain Valley, Custer County, consists of animals too poorly preserved to be of any real value in these comparisons.

If color of venter is taken to be diagnostic, then the name *infraluteus* seemingly is applicable only to specimens from the type locality. However, a number of facts seem to me to contraindicate such restriction. Individual variation has been noted in the supposedly diagnostic character within a small series of topotypes. The character in question was observed (to a limited degree) in some individuals from Albany and Laramie counties, Wyoming, but not in available material from Colorado other than from the type locality. I know of no character, other than ventral color, that will consistently separate specimens of *infraluteus* and *olivaceogriseus.* In dorsal color, topotypes of *infraluteus* agree more closely with specimens from eastern Wyoming and western Nebraska than with other Coloradan specimens, which tend to be more heavily overlaid with black on the dorsum. Whether, in fact, *olivaceogriseus* is to be considered a synonym of *infraluteus* is a judgment that must await the accumulation of further material, especially from central Colorado. In the meantime, to consider all specimens from eastern Colorado to represent a single subspecies seems to me to be the conservative course.

Records of occurrence.—Specimens examined, 42, distributed as follows: LARIMER COUNTY: Loveland, 11 (1 ANSP, 10 USNM). WELD COUNTY: 2 1/2 mi. N, 12 1/2 mi. E Fort Collins, 1 (CSU); *13 mi. E Fort Collins,* 1 (CSU). JEFFERSON COUNTY: Green Mountain, 5 mi. W Denver, 1 (KU). ELBERT COUNTY: 7 mi. N Ramah, 1 (UMMZ). FREMONT COUNTY: 23 7/10 mi. (by road) NE Silver Cliff, 6200 ft., 1 (KU); *14 8/10 mi. (by road) NE Silver Cliff, 7800 ft.,* 1 (KU); 13 6/10 mi. (by road) NE Silver Cliff, 7980 ft., 1 (KU). CUSTER COUNTY: *12 4/10 mi. (by road) NE Silver Cliff,* 1 (KU); *11 2/10 mi. (by road) NE Silver Cliff, 8200 ft.,* 2 (KU); *10 4/10 mi. (by road) NE Silver Cliff, 8025 ft.,* 2 (KU); 9 *6/10 mi. (by road) NE Silver Cliff, 7989 ft.,* 1 (KU); 9 *2/10 mi.*

(by road) NE Silver Cliff, 8000 ft., 1 (KU); *8 4/10 mi. (by road) NE Silver Cliff, 8200 ft.,* 1 (KU); *6 8/10 mi. (by road) NE Silver Cliff, 8200 ft.,* 5 (KU); *6 4/10 mi. (by road) NE Silver Cliff, 8200 ft.,* 3 (KU); *5 6/10 mi. (by road) NE Silver Cliff, 8050 ft.,* 1 (KU); *4 4/10 mi. (by road) NE Silver Cliff, 7950 ft.,* 1 (KU); *3 6/10 mi. (by road) NE Silver Cliff, 7975 ft.,* 1 (KU); *2 4/10 mi. (by road) NE Silver Cliff, 7970 ft.,* 3 (KU); 1 2/10 mi. (by road) NE Silver Cliff, 7900 ft., 1 (KU). HUERFANO COUNTY: 4 mi. S La Veta, 7000 ft., 1 (KU).

Perognathus apache

APACHE POCKET MOUSE

Perognathus apache enters Colorado in arid valleys of the Western Slope and in the San Luis Valley. The range of the species is bounded roughly by the Grand Valley of the Colorado River on the north and west, and extends eastward to the valley of the Rio Grande. Apache pocket mice generally inhabit sandy sites where burrows are constructed beneath cactus or low brush. Douglas (1963) captured specimens in a seral grassland established on a site where piñon-juniper woodland had burned off. Except for incidental observations, the natural history of *P. apache* in Colorado is unknown.

Perognathus apache apache Merriam

Perognathus apache Merriam, N. Amer. Fauna, 1:14, 25 October 1889; type locality, Keam Canyon, Apache Co., Arizona.

Distribution in Colorado.—Known only from the San Juan watershed, Montezuma and La Plata counties (Fig. 58).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa.

Measurements.—External measurements of a young adult female are: 126, 60, 16, 6, weight, 10.1. Cranial measurements of that individual are presented in table 16.

Records of occurrence.—Specimens examined, 3, distributed as follows: MONTEZUMA COUNTY: Morfield Mesa, Mesa Verde National Park, 7525 ft., 2 (KU). LA PLATA COUNTY: 8 mi. S Ignacio, 6100 ft., 1 (UNM).

Perognathus apache caryi Goldman

Perognathus apache caryi Goldman, Proc. Biol. Soc. Washington, 31:24, 16 May 1918; type locality, 8 mi. W Rifle, Garfield Co., Colorado.

Distribution in Colorado.—Semiarid valleys of west-central part of state (Fig. 58).

Comparison.—From *P. a. apache*, the subspecies of the San Juan drainage, *P. a. caryi* differs in darker dorsal color (more heavily washed with black) and generally larger, more massive skull (after Goldman, 1918).

Measurements.—External measurements of three males from Bedrock, Montrose County, are: 144, 140, 139; 70, 67, 68; 18, 18, 19. For cranial measurements, see table 16.

Remarks.—Records of occurrence at Balzac (Warren, 1942:177) and Morris (Cary, 1911:147) apparently refer to the holotype and topotypes.

Records of occurrence.—Specimens examined, 9, distributed as follows: GARFIELD COUNTY: 8 mi. W Rifle, 3 (USNM). MESA COUNTY: Badger Wash, NW of Mack, 1 (CSU); Stateline, 1 (MVZ); Sieber Ranch, Little Dolores Creek, 1 (WC). MONTROSE COUNTY: Bedrock, 5150 ft., 2 (WC).

Additional records: MESA COUNTY: N of Fruita (Cary, 1911:147); *1/4 mi. W Red Canyon Overlook, Colorado National Monument, 6400 ft.* (P. H. Miller, 1964:56); 1/4 mi. SE East Entrance Ranger Station (Miller, *loc. cit.*). MONTROSE COUNTY: Coventry (Cary, *loc. cit.*).

Perognathus apache relictus Goldman

Perognathus apache relictus Goldman, Jour. Mamm., 19:495, 14 November 1938; type locality, Medano Springs Ranch, 7600 ft., 15 mi. NE Mosca, Alamosa Co., Colorado.

Distribution in Colorado.—Known at present only from the San Luis Valley, north and east of the Rio Grande (Fig. 58).

Comparison.—From *P. a. apache*, the subspecies of the San Juan drainage, *P. a. relictus* differs in being generally darker buff dorsally, more profusely mixed with black, and in having smaller bullae (after Goldman, 1938b).

Measurements.—Mean (and extreme) external measurements of six males, followed by measurements of a female, all from the type locality, are: 134.7 (127-145), 137; 65.2 (61-71), 65; 18.8 (18-20), 19. Selected cranial measurements are presented in table 16.

Remarks.—The three subspecies of *P. apache* in Colorado are separated by ecological and physiographic barriers. Such barriers also separate *P. apache* from populations of the closely related species *P. fasciatus* in the state.

Records of occurrence.—Specimens examined, 23, distributed as follows: ALAMOSA COUNTY: Medano Ranch, 15 mi. NE Mosca, 10 (2 MVZ, 1 USNM, 7 WC); *Great Sand Dunes National Monument,* 12 (1 GSDNM, 11 MVZ); 3 mi. S Great Sand Dunes National Monument, 1 (MVZ).

Perognathus flavescens

Plains Pocket Mouse

Perognathus flavescens is a mammal of the central grasslands of North America, ranging from the upper Mississippi Valley westward to the Rocky Mountains of Wyoming and Colorado, and from North Dakota southward to Texas. In Colorado, the species is known from the plains north of the Arkansas River and probably occurs in the extreme southeastern part of the state as well. Apparently the species is most abundant in Colorado in the sand hills south of the South Platte River. Typical habitat is communities of grasses with scattered shrubs and cacti. Maxell and Brown (1968) described habitat preferences of the plains pocket mouse in eastern Wyoming; *P. flavescens* was found to be more euryecious than either *P. fasciatus* or *P. flavus,* occurring over a variety of plant communities and types of substrate. The ecology of *P. flavescens* in Colorado has not been studied, nor is it well known anywhere within the range of the species.

Perognathus flavescens flavescens Merriam

Perognathus fasciatus flavescens Merriam, N Amer. Fauna, 1:11, 25 October 1889; type locality, Kennedy, Cherry Co., Nebraska.

Perognathus flavescens, Osgood, N. Amer. Fauna, 18:20, 20 September 1900.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 59).

Comparison.—From *P. f. copei,* the subspecies of the Texas Panhandle and adjacent areas, *P. f. flavescens* differs principally in slightly less pallid color.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of five females, all from northern Washington County, are: 125.8 (123-132), 125.2 (120-131); 56.5 (52-61), 58.4 (54-64); 17.5 (16-19), 16.4 (14-18); weight, 10.83 (10.0-12.0), 8.62 (7.0-11.5). For cranial measurements, see table 16.

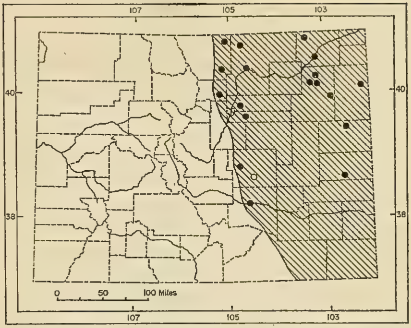


Fig. 59. Distribution of *Perognathus flavescens flavescens* in Colorado. For explanation of symbols, see p. 9.

Remarks.—Coloradan records of *P. flavescens* are from localities scattered over the plains and no definable geographic variation is apparent within the state. Specimens that I have examined agree well with mice from the Sand Hills of Nebraska, representatives of the nominotypical subspecies. None is as dark as representatives of *P. f. cockrumi* from central Kansas. I have not examined specimens of *P. f. copei;* were specimens of the plains pocket mouse available from Colorado south of the Arkansas River, they might be expected to resemble that pallid race.

Records of occurrence.—Specimens examined, 50, distributed as follows: LARIMER COUNTY: Lindenmeier, 1 (USNM); Loveland, 1 (USNM). WELD COUNTY: 9 mi. N Nunn, 5400 ft., 1 (CSU); *Central Plains Experiment Station,* 1 (CSU); Greeley, 2 (USNM). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU); Sterling, 3 (USNM). BOULDER COUNTY: Boulder, 1 (USNM). ADAMS COUNTY: 3 mi. NE Fitzsimmons, 1 (DMNH). ARAPAHOE COUNTY: 15 mi. E Denver, 2 (DMNH). WASHINGTON COUNTY: Eastern Colorado Range Experiment Station, 14 mi. N Akron, 18 (2 KU, 16 UU); 8 mi. W Akron, 1 (UMMZ); Akron, 6 (UMMZ); 10 mi. S, 7 mi. E Otis, 1 (KU); *no locality other than county,* 3 (UMMZ). YUMA COUNTY: N of Wray, 1 (CU). KIT CARSON COUNTY: Tuttle, 1 (USNM). EL PASO COUNTY: 6 mi. E Colorado Springs, 1 (UMMZ). CHEYENNE COUNTY: 1 mi. N, 8 mi. E Kit Carson, 1 (KU). PUEBLO COUNTY: Pueblo, 2 (USNM).

Additional record: EL PASO COUNTY: Peyton Road, 14 mi. E Fountain (Norris and Banta, 1965: 55).

Perognathus flavus

SILKY POCKET MOUSE

Perognathus flavus is a mammal of the central and southern parts of the Great Plains and the Mexican Plateau. In Colorado it is widespread on the eastern plains, extending in the Upper Arkansas Valley to the vicinity of Salida, at about 7000 feet. In the San Luis Valley, the species is widespread at about 7600 feet, occurring to at least 8300 feet along the Conejos River. A third population occurs in Colorado only in western Montezuma County. The three areas of occurrence of the species in Colorado are separated by strong ecological barriers that doubtless preclude direct genetic communication between the populations. Typical habitat is semiarid grasslands on light, sandy soils, but shrublands also are occupied. Burrows typically are beneath *Yucca, Opuntia,* or low shrubs. Some ecological data on *P. flavus* were provided by Banta and Norris (1968). Maxell and Brown (1968) studied habitat preferences of the species in eastern Wyoming; *P. flavus* was found to utilize grass associations, whereas *flavescens* was more prevalent in shrub communities. For details on growth and reproduction of silky pocket mice in New Mexico, see Forbes (1964).

Perognathus flavus bunkeri Cockrum

Perognathus flavus bunkeri Cockrum, Univ. Kansas Publ., Mus. Nat. Hist., 5:205, 15 December 1951; type locality, 1 mi. E Coolidge, Hamilton Co., Kansas.

Distribution in Colorado.—Plains of eastern two-fifths of state, west in Arkansas Valley to vicinity of Salida (Fig. 60).

Comparisons.—From *P. f. flavus,* the subspecies of New Mexico and western Texas, *P. f. bunkeri* differs in larger average cranial size (except occipitonasal length and width of interparietal) and more buffy (less pinkish) dorsal color, slightly less heavily overlaid with black.

From *P. f. sanluisi,* the subspecies of the San Luis Valley, *P. f. bunkeri* differs in larger cranial size (except width of interparietal) and paler color, less heavily overlaid with black. For more detailed comparisons, see Cockrum (1951).

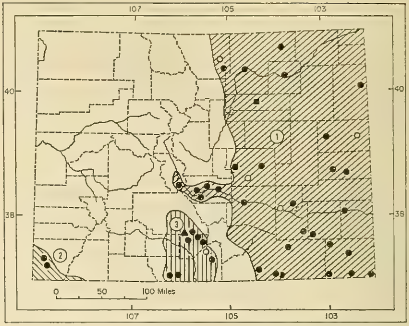


FIG. 60. Distribution of *Perognathus flavus* in Colorado. 1. *P. f. bunkeri.* 2. *P. f. hopiensis.* 3. *P. f. sanluisi.* For explanation of symbols, see p. 9.

From *P. f. hopiensis,* the subspecies of extreme southwestern Colorado and adjacent areas, *P. f. bunkeri* differs in larger average cranial size and richer (more buffy and less grayish) dorsal color.

Measurements. — External measurements of two males, followed by the average (and extremes) of five females, all from Garden Park, Fremont County, are: 105, 106, 100.4 (97-104); 50, 48, 44.8 (41-49); 18, 16, 15.2 (12-17). Cranial measurements are presented in table 16.

Remarks.—The color of specimens from eastern Colorado varies widely, particularly in the degree to which the dorsum is overlaid with black hairs. Specimens from Weld County are consistently more heavily washed with black than those from elsewhere on the plains, approaching the color of *P. f. piperi.* Of comparable color are specimens from 3 mi. W Salida (DMNH 3702) and 16 mi. WNW Cañon City (CSU 10210). The dark color of specimens from the Upper Arkansas Valley may indicate the influence of *P. f. sanluisi,* although the population in the Arkansas Valley above Royal Gorge probably is today mostly or completely isolated from the ranges of other populations by marginal or unsuitable habitat. Specimens from Trinchera (DMNH 390, 391), near Trinidad (KU 59866), and near Branson (KU 68454) also are relatively dark, approaching the color of *P. f. flavus,* but other specimens from the southeastern part of the state (for example, DMNH 2152-2154 from Furnace Canyon and MVZ 6867 from Springfield) are the distinctive pale color of *bunkeri.*

Thus, apparent intergradation with other subspecies occurs near the northern and southern boundaries of the state, and in the Upper Arkansas Valley. These areas of intermediacy are zones of restricted or obstructed gene flow. On the north, the Pawnee Buttes, the Peetz Table, and other features mark the limit of headward cutting by northern tributaries of the South Platte River. This area of rough land and heavy soils must support a meager population of silky pocket mice. Similarly, in the south, the continuity of the range of *P. flavus* is interrupted (to an unknown degree) by the rough country of the Raton Section. Pocket mice of the Upper Arkansas Valley are separated from those of the San Luis Valley by the unsuitable habitat of Poncha Pass.

Records of occurrence.—Specimens examined, 70, distributed as follows: LARIMER COUNTY: Loveland, 8 (USNM). WELD COUNTY: Central Plains Experiment Station, 9 mi. N Nunn, 1 (UU); Horsetail Creek, 17 mi. NW Stoneham, 1 (DMNH); Greeley, 5 (USNM). MORGAN COUNTY: Muir Springs, 2 mi. N, 2 1/2 mi. W Fort Morgan, 1 (KU). ADAMS COUNTY: *no locality other than county,* 1 (DMNH). YUMA COUNTY: Wray, 1 (DMNH). KIT CARSON COUNTY: 4 mi. E Flagler, 1 (KU). CHAFFEE COUNTY: 3 mi. W Salida, 1 (DMNH); *Salida,* 6 (2 USNM, 4 WC). EL PASO COUNTY: 4 mi. E Ellicott, 2 (UMMZ); E of Colorado Springs, 1 (WC). CHEYENNE COUNTY: 3 mi. SW Sorrento, 1 (KU); 10 mi. S Firstview, 2 (CU). FREMONT COUNTY: 16 mi. WNW Cañon City, 1 (CSU); Garden Park, [N of] Cañon City, 7 (DMNH); *7 mi. W Cañon City,* 1 (TCWC); 6 mi. N Cotopaxi, 3 (UU); Texas Creek, between Rito and Hillside, 7000 ft., 1 (WC). PUEBLO COUNTY: 5 mi. W Pueblo, 1 (SCSC). CROWLEY COUNTY: near Lake Henry, 1 (FWS); *no locality other than county,* 1 (FWS). OTERO COUNTY: Higbee, 5 (USNM). BENT COUNTY: SW corner of county, 3 (CU). PROWERS COUNTY: 1 1/2 mi. W Lamar, 1 (CU). LAS ANIMAS COUNTY: 9 mi. W junction Purgatoire and Chacuacho rivers, 3 (MVZ); 1 mi. S, 7 mi. W Trinidad, 1 (KU); Trinchera, 2 (DMNH); 3 mi. W Branson, 1 (KU). BACA COUNTY: Gaume's Ranch, 1 (USNM); Bear Creek, NW of Springfield, 1 (MVZ); *N of Springfield,* 2 (CU); Furnace [Furnish] Canyon, 3 (DMNH); Regnier, 1 (DMNH); Craugh Ranch, Cimarron River, 1 (DMNH).

Additional records: LARIMER COUNTY: Spring Canyon, 4 mi. SW Fort Collins (Cary, 1911:147). KIT CARSON COUNTY: Burlington (Cockrum, 1951:206); *Flagler* (Cary, *loc. cit.*). EL PASO COUNTY: Peyton Road, 14 mi. E Fountain (Norris and Banta, 1965:55). FREMONT COUNTY: *Cañon City* (Cockrum, 1951:206). CROWLEY COUNTY: Olney [Springs] (Cary, 1911:146).

Perognathus flavus hopiensis Goldman

Perognathus flavus hopiensis Goldman, Proc. Biol. Soc. Washington, 45:89, 21 June 1932; type locality, Oraiba, Hopi Reservation, 6000 ft., Navajo Co., Arizona.

Distribution in Colorado.—Known only from western Montezuma County (Fig. 60).

Comparisons.—From *P. f. sanluisi,* the subspecies of the San Luis Valley, *P. f. hopiensis* differs in paler color, less heavily overlaid with black. For comparison with *P. f. bunkeri,* see account of that subspecies.

Measurements.—External measurements of a female (DMNH 697) from Ute Peak, followed by those of the holotype (a female, USNM 248014), are: 114, 115; 56, 50; 17, 15. Representative cranial measurements of the holotype include (Goldman, 1932b:89): occipitonasal length, 19.7; greatest breadth across bullae, 12.0; interorbital breadth, 4.4; length of nasals, 7.0; width of interparietal, 2.5; length of maxillary toothrow, 2.9.

Records of occurrence.—Specimens examined, 2, distributed as follows: MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 1 (USNM); Ute Peak, 1 (DMNH).

Perognathus flavus sanluisi Hill

Perognathus flavus sanluisi Hill, Amer. Mus. Novit., 1212:1, 7 December 1942; type locality, 9 mi. E Center, *in* Alamosa Co., Colorado.

Distribution in Colorado.—San Luis Valley (Fig. 60).

Comparisons.—For comparisons with other Coloradan subspecies, see accounts of those races.

Measurements.—Mean (and extreme) external measurements of seven males, followed by those of four females, all from Alamosa and Costilla counties, are: 112.0 (108-118), 110.0 (108-114); 51.6 (46-58), 48.0 (45-52); 15.7 (15-17), 15.8 (15-16); 5.3 (4-7), 5.2 (4-6); weight, 7.60 (6.5-8.8), 8.08 (6.5-9.0). Selected cranial measurements are presented in table 16.

Records of occurrence.—Specimens examined, 72. distributed as follows: SAGUACHE COUNTY: 5 mi. NW Hooper, 7 (DMNH). ALAMOSA COUNTY: 9 mi. E Center, 37 (36 AMNH, 1 KU); San Luis Lakes, 1 (WC); *Medano Ranch, 15 mi. NE Mosca,* 10 (6 MVZ, 3 USNM, 1 WC); Mosca, 2 (WC); 3 mi. S Great Sand Dunes National Monument, 2 (MVZ). CONEJOS COUNTY: Conejos River, 8300 ft., 5 (USNM); Antonito, 1 (USNM). COSTILLA COUNTY: *Fort Garland,* 5 (4 MVZ, 1 USNM); *5 mi. SSW Fort Garland,* 1 (AMNH); 5 mi. SSE Fort Garland, 1 (AMNH).

Additional record: COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:281).

Perognathus hispidus

Hispid Pocket Mouse

The hispid pocket mouse is the largest of the five nominal species of *Perognathus* known to occur in Colorado. Seemingly, *Perognathus hispidus* is less restricted to areas of sandy soils than are other species of pocket mice. Typical habitat in eastern Colorado is open areas with a light cover of bunch grasses. Maxell and Brown (1968) found the species to be euryecious in eastern Wyoming, with some preference for areas of sandy loam and loam.

Perognathus hispidus is readily distinguished from other species of pocket mice that occur in Colorado by its large size and markedly harsh pelage. Glass (1947) studied geographic variation in the hispid pocket mouse, concluding that a single subspecies occurs over much of the central Great Plains. His treatment is followed here.

Perognathus hispidus paradoxus Merriam

Perognathus paradoxus Merriam, N. Amer. Fauna, 1:24, 25 October 1889; type locality, Banner, Trego Co., Kansas.

Perognathus hispidus paradoxus, Osgood, N. Amer. Fauna, 18:44, 20 September 1900.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 61).

Measurements.—External measurements of two males from Douglas County and two females from Larimer County are, respectively: 256, 250, 200, 220; 126, 122, 98, 108; 29, 29, 25, 27; —, —, 9, 8; weights of the females, 39.1, 43.0. Representative cranial measurements of two males from Douglas County, and of two males and a female from Larimer County, are, respectively: occipitonasal length, 35.8, 35.8, 30.0, 29.6, 31.5; zygomatic breadth, 17.7, —, —, 15.6, —; interorbital constriction, 7.8, 7.8, 7.7, 7.2, 7.4; breadth of interparietal, 8.0, 8.8, 7.7, 7.8, 8.0; length of maxillary toothrow, 5.1, 5.3, 4.9, 4.7, 4.9.

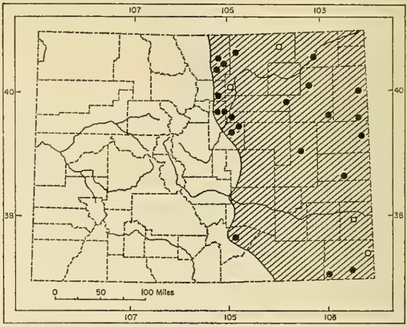


FIG. 61. Distribution of *Perognathus hispidus paradoxus* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 41, distributed as follows: LARIMER COUNTY: 5 mi. W Fort Collins, 1 (CSU); *Maxwell Ranch, 4 mi. W Fort Collins,* 1 (CSU); *3 mi. W Fort Collins,* 1 (CSU); *2 1/2 mi. W Fort Collins,* 1 (CSU); *2 mi. W Fort Collins,* 1 (CSU); *1/4 mi. S Spring Canyon Dam,* 1 (CSU); *Fort Collins,* 1 (CSU); 5 mi. S Fort Collins, 1 (CSU); 6 mi. S, 7 mi. W Fort Collins, 1 (CSU); *1/2 mi. S, 6 mi. W Loveland, 5200 ft.,* 1 (KU). WELD COUNTY: Central Plains Experiment Station, near Nunn, 1 (UNM). LOGAN COUNTY: Sterling, 2 (USNM). BOULDER COUNTY: Boulder, 1 (CU). JEFFERSON COUNTY: 10 mi. W Denver, 1 (CSC); *Green Mountain, 5 mi. W Denver, 5500 ft.,* 2 (CSU); 4 mi. W Denver, 5000 ft., 1 (CSU). ADAMS COUNTY: *3 mi. S, 1 mi. W Simpson,* 1 (KU); 25 mi. S Fort Morgan, 1 (UMMZ). ARAPAHOE COUNTY: Cherry Creek, SE of Denver, 5280 ft., 1 (CSU). WASHINGTON COUNTY: Akron, 1 (UMMZ); Cope, 1 (KU). YUMA COUNTY: Wray, 6 (DMNH); W end Bonny Reservoir, 1 (CU). DOUGLAS COUNTY: Parker, 1 (DMNH); *3 mi. SE Parker,* 1 (DMNH); Daniel's Park, 1 (DMNH). LINCOLN COUNTY: Hugo, 1 (USNM). KIT CARSON COUNTY: 3 mi. NE Burlington, 1 (KU). CHEYENNE COUNTY: 10 mi. S Firstview, 1 (CU). HUERFANO COUNTY: 1 mi. S, 2 mi. W Walsenburg, 3 (KU). BACA COUNTY: 2 mi. E Campo, 1 (AMNH); Furnace [Furnish] Canyon, 1 (DMNH).

Additional records: WELD COUNTY: Horsetail Creek (Glass, 1947:179); St. Vrain River, 1 mi. S, 6 mi. W Platteville (Archibold, 1964:44). PROW-

ERS COUNTY: no precise locality (Cary, 1911: 144). BACA COUNTY: Monon (Warren, 1906: 253).

Dipodomys ordii

ORD'S KANGAROO RAT

Ord's kangaroo rat is to be found in arid and semiarid situations over much of Colorado at lower elevations. The highest records of occurrence are about 8300 feet in the San Luis Valley. The animals show a distinct predilection for areas of sandy soils, and because of the distribution of such soils, the distribution of local populations is spotty. Sand bars and sandy banks of ephemeral streams seem to present optimal habitat for the species and frequently are areas of high populations. Kangaroo rats are exclusively nocturnal, retiring by day to burrows in the sand, the entrances of which are closed behind them. Systems of tunnels sometimes are extensive and the work of these rodents may undermine the banks of arroyos or borrow-pits causing them to slough, thus hastening erosion. In suitable habitats, populations of *Dipodomys ordii* may be high and the animals are readily trapped or captured by hand in considerable numbers.

Setzer (1949) studied geographic variation in *D. ordii* throughout its extensive range in western North America. That study has been utilized extensively in drafting the accounts of subspecies beyond.

Dipodomys ordii evexus Goldman

Dipodomys ordii evexus Goldman, Jour. Washington Acad. Sci., 23:468, 15 October 1933; type locality, Salida, Chaffee Co., Colorado.

Distribution in Colorado.—Upper Arkansas Valley, from vicinity of Salida eastward to vicinity of Cañon City (Fig. 62).

Comparisons. — From *D. o. richardsoni*, the subspecies adjacent to the east, *D. o. evexus* differs in smaller average external and cranial size and darker color, the pelage of the dorsum being cinnamon-buff suffused with black hairs. For comparison with *D. o. montanus*, see the account of that subspecies.

Measurements.—Mean (and extreme) external measurements of 16 males, followed by those of 10 females, all from Chaffee and Fremont counties, are: 262.4 (240-280), 264.0 (241-274); 150.3 (133-163), 148.7 (138-159); 41.2 (37-43), 41.0 (39-43). For representative cranial measurements, see table 17.

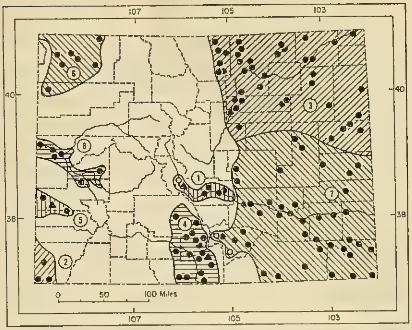


FIG. 62. Distribution of *Dipodomys ordii* in Colorado. 1. *D. o. evexus.* 2. *D. o. longipes.* 3. *D. o. luteolus.* 4. *D. o. montanus.* 5. *D. o. nexilis* 6. *D. o. priscus.* 7. *D. o. richardsoni.* 8. *D. o. sanrafaeli.* For explanation of symbols, see p. 9.

Remarks.—Simply on geographic considerations, one would expect kangaroo rats from the Arkansas Valley below Royal Gorge to agree with the population of the plains to the east and not with the subspecies of the Upper Arkansas Valley. On morphologic grounds, however, that is not the case. Certainly gene flow must be severely restricted by the Royal Gorge and other sections of the middle Arkansas Valley. Probably local populations at Salida and Cañon City are essentially isolated from each other.

The ranges of *D. o. evexus* and *D. o. montanus* are separated by the Sangre de Cristo Range, presently a barrier between the two populations even at Poncha Pass, the low northern terminus of the range.

Setzer (1949:519) referred a specimen from Pueblo to *D. o. evexus.* Additional specimens now are available from that area and they appear to me to be referable to *D. o. richardsoni.* Coues and Yarrow (1875:109) listed a specimen from Twin Lakes, but I doubt that *D. ordii* has occurred at that elevation (about 9200 feet) in the Arkansas Valley within historic time.

Records of occurrence.—Specimens examined, 71, distributed as follows: CHAFFEE COUNTY: *3 mi.*

TABLE 17

Selected cranial measurements of seven subspecies of *Dipodomys ordii.*

Number averaged (or catalog number), sex	Greatest length of skull	Greatest breadth across bullae	Breadth across maxillary arches	Basilar length	Length of nasals	Interorbital constriction	Length of maxillary toothrow
Dipodomys ordii evexus, Chaffee and Fremont counties							
Mean, 9 ♂	38.23	23.43	21.68	25.78	13.83	12.53	4.89
Minimum	37.4	22.5	21.4	25.4	13.2	11.8	4.4
Maximum	39.8	24.3	22.2	26.1	14.4	13.5	5.2
Mean, 8 ♀	38.38	23.62	21.48	24.93	13.82	12.69	4.89
Minimum	37.5	23.1	20.4	24.0	12.9	11.5	4.5
Maximum	40.0	24.9	22.8	25.6	14.6	13.4	5.2
Dipodomys ordii luteolus, near topotypes, Natrona Co., Wyoming							
Mean, 11 ♂	38.42	23.84	20.41	24.55	14.06	12.70	5.21
Minimum	37.2	22.9	19.7	23.5	13.5	11.8	4.8
Maximum	39.3	24.5	21.6	25.5	14.6	13.7	5.5
Mean, 4 ♀	38.70	24.07	20.88	24.50	14.38	13.02	5.05
Minimum	38.4	23.6	20.2	24.4	14.3	12.8	4.7
Maximum	39.1	24.8	21.6	24.6	14.6	13.5	5.3
Yuma and Kit Carson counties							
Mean, 5 ♂	39.40	24.08	21.20	25.05	14.66	12.47	5.06
Minimum	38.6	23.5	20.0	24.9	14.4	12.3	4.5
Maximum	40.7	24.9	22.7	25.2	15.0	12.6	5.5
Mean, 4 ♀	40.10	24.65	21.88	25.95	14.92	13.20	5.15
Minimum	38.1	23.5	21.6	25.5	13.9	12.6	4.8
Maximum	41.9	25.6	22.5	26.5	15.4	13.5	5.4
Dipodomys ordii montanus, Alamosa and Costilla counties							
Mean, 10 ♂	38.54	24.74	20.66	24.79	14.07	12.40	5.10
Minimum	38.1	23.9	20.1	24.0	13.8	11.7	4.9
Maximum	38.9	25.2	21.1	25.5	14.8	12.9	5.2
Mean, 6 ♀	37.86	24.03	19.90	24.50	13.74	12.52	4.70
Minimum	36.6	23.9	18.8	24.3	13.3	12.0	4.0
Maximum	38.7	24.2	20.7	24.7	14.3	12.8	5.1
Dipodomys ordii nexilis, southwestern Montrose County							
Mean, 10 ♂	41.01	26.26	21.71	26.32	14.69	13.26	5.16
Minimum	40.0	25.0	20.4	25.8	14.1	12.8	4.8
Maximum	42.4	27.5	22.3	27.3	15.1	13.6	5.3
Mean, 4 ♀	40.70	26.20	21.87	25.90	14.88	13.12	5.20
Minimum	39.8	25.9	21.7	25.5	14.5	12.4	4.9
Maximum	41.8	26.4	22.3	26.5	15.4	13.5	5.4
Dipodomys ordii priscus, north-central Moffat County							
DMNH 2052, ♂	39.7	—	21.6	—	14.9	13.3	5.0
Mean, 4 ♀	39.82	24.38	21.20	25.20	14.72	12.84	5.10
Minimum	39.0	24.2	20.6	25.0	14.2	12.0	5.0
Maximum	40.4	24.6	21.5	25.5	15.2	13.2	5.3

TABLE 17 (Continued)

Selected cranial measurements of seven subspecies of *Dipodomys ordii.*

Number averaged (or catalog number), sex	Greatest length of skull	Greatest breadth across bullae	Breadth across maxillary arches	Basilar length	Length of nasals	Interorbital constriction	Length of maxillary toothrow
Dipodomys ordii richardsoni, near topotypes, Beaver Co., Oklahoma							
Mean, 10 ♂	40.93	24.79	21.85	26.27	15.28	12.96	5.50
Minimum	39.7	24.0	21.0	24.5	14.1	12.4	5.3
Maximum	41.8	25.5	22.3	27.0	15.7	13.7	5.0
vicinity of Lamar, Prowers County							
Mean, 5 ♂	40.50	24.70	21.75	25.60	14.88	13.02	5.24
Minimum	39.4	24.3	21.0	15.1	14.1	12.8	4.9
Maximum	41.4	25.1	22.3	26.0	16.0	13.3	5.4
Mean, 7 ♀	39.66	24.27	21.30	25.06	14.97	12.99	5.27
Minimum	38.9	23.1	20.7	24.5	14.3	12.3	5.1
Maximum	41.1	24.8	21.8	25.3	15.7	13.5	5.4
SE of Hasty, Bent County							
Mean, 6 ♂	39.90	24.42	21.47	25.85	14.85	12.78	5.40
Minimum	39.5	23.7	20.5	25.4	14.6	11.9	5.2
Maximum	40.5	25.0	22.5	26.6	15.0	13.3	6.0
Dipodomys ordii sanrafaeli, vicinity of Grand Junction, Mesa County							
Mean, 5 ♀	39.20	24.86	20.28	24.58	14.32	11.56	4.96
Minimum	38.3	23.6	19.0	23.5	13.9	10.5	4.6
Maximum	40.5	25.6	21.4	25.7	14.7	12.8	5.2
8 mi. W Olathe, Montrose County							
DMNH 3337, ♀	37.7	24.0	20.1	——	13.6	12.6	5.0
DMNH 3338, ♀	38.0	24.0	20.5	23.7	13.6	12.1	4.7

W Salida, 8 (DMNH); Salida, 7100 ft., 28 (7 AMNH, 6 USNM, 15 WC). FREMONT COUNTY: 21 mi. NW Cañon City, 2 (CU); S end of Garden Park, 4 (DMNH); *2 mi. NW Cañon City,* 1 (DMNH); 1 mi. N, 7 mi. E Cañon City, 5400 ft., 1 (KU); Cañon City, 27 (6 DMNH, 21 USNM).

Additional record: CHAFFEE COUNTY: Brown's Canyon, 7 mi. above Salida (Cary, 1911: 141).

Dipodomys ordii longipes (Merriam)

Dipodops longipes Merriam, N. Amer. Fauna, 3:72, 11 September 1890; type locality, foot of Echo Cliffs, Painted Desert, Coconino Co., Arizona.

Dipodomys ordii longipes, Grinnell, Jour. Mamm., 2:96, 2 May 1921.

Distribution in Colorado. — Known only from southwestern Montezuma County (Fig. 62).

Comparison.—From *D. o. nexilis,* the subspecies of the Dolores River Valley to the north, topotypes of *D. o. longipes* differ in larger size, both externally and cranially, and in paler color (less strongly suffused with black).

Measurements.—External measurements of three young adult males from southwestern Montezuma County are: 260, 257, 238; 148, 159, 137; 41, 42, 40. I have examined no undamaged skulls of Coloradan specimens. Representative cranial measurements of two males and a female from Kayenta, Navajo Co., Arizona (Setzer, 1949:569), include: greatest length of skull, 39.3, 38.4, 39.9; greatest breadth across bullae, 25.5, 25.4, 25.7; breadth across maxillary arches, 20.7, 20.6, 21.2; length of nasals, 13.8, 13.3, 13.8; basilar length, 24.3, 24.6, 25.4; least interorbital width, 13.0, 12.7, —.

Remarks.—Intergradation between *D. o. longipes* and *D. o. nexilis* has not been demonstrated in Colorado, but is to be expected; Setzer (1949:557) noted that the two subspecies intergrade north of the San Juan

River in Utah. The small sample of *longipes* available from Colorado is inadequate to characterize the subspecies; the primary difference between *longipes* and *nexilis* is in color.

Records of occurrence.—Specimens examined, 9, distributed as follows: MONTEZUMA COUNTY: *Rock Creek, McElmo Canyon,* 2 (CSU); Ashbaugh's Ranch [Moqui], 1 (WC); Mancos River, near Four Corners, 2 (DMNH); San Juan River, Four Corners, 4 (DMNH).

Dipodomys ordii luteolus (Goldman)

Perodipus ordii luteolus Goldman, Proc. Biol. Soc. Washington, 30:112, 23 May 1917; type locality, Casper, Natrona Co., Wyoming.

Dipodomys ordii luteolus, Grinnell, Jour. Mamm., 2:96, 2 May 1921.

Distribution in Colorado.—Plains of northeastern part of state, generally the drainage of the South Platte River (Fig. 62).

Comparison.—From topotypes of *D. o. richardsoni,* topotypical specimens of *D. o. luteolus* differ in generally larger external size, paler color, and smaller cranial size. Additionally, in most specimens of *richardsoni* the ventral stripe of the tail is continuous with the dark hairs of the "pencil," but in *luteolus* the ventral stripe typically is present only on the proximal two-thirds of the tail.

Measurements.—Average (and extreme) external measurements of 11 males and four females, all from Natrona County, Wyoming, are: 265.8 (254-281), 259.0 (250-269); 152.9 (145-163), 146.0 (139-151); 41.9 (40-43), 42.2 (41-43); 13.5 (12-14), 14.2 (14-15). Mean (and extreme) external measurements of six males, followed by those of four females, all from Yuma and Kit Carson counties, are: 267.3 (256-289), 271.2 (263-283); 149.3 (141-152), 151.2 (143-156); 41.7 (40-43), 41.5 (41-42); 14.5 (13-15), 15.2 (14-16). For cranial measurements, see table 17.

Remarks.—Distinction between *D. o. luteolus* and *D. o. richardsoni* over much of the Colorado Piedmont is tenuous at best. Assignment of individual specimens to subspecies generally is arbitrary, and series of specimens from some localities are sufficiently variable to preclude certain allocation to one named population or the other. Topotypical series of *luteolus* and *richardsoni* are readily distinguishable on the basis of color and size. In general, specimens from Larimer and Weld counties agree well with those from Natrona County, Wyoming, and specimens from the southeast—Bent, Prowers, Las Animas, and Baca counties—agree with those from Beaver County, Oklahoma. In the broad area between the South Platte and Arkansas rivers, however, populations of the species are highly variable. That whole area is best considered a zone of intergradation between the two subspecies. The boundary between subspecies is drawn along the divide between the South Platte and Arkansas watersheds. Although some specimens from both sides of the boundary might be assigned with equal justification to either subspecies, the line is not altogether arbitrary. In my experience, the area of heavy soils along the divide supports low numbers of kangaroo rats relative to areas to the north and south where soils typically are sandier and lighter. The boundary is nonetheless one of convenience, given the present state of our knowledge, and is accorded little zoogeographic importance.

Records of occurrence.—Specimens examined, 218, distributed as follows: LARIMER COUNTY: Goodwin Ranch, Box Elder Creek, T. 11 N, R. 69 W, 9 (CSU); Owl Canyon, 1 (CSU); 2 mi. S Waverly, 1 (CSU); *8 mi. N Fort Collins,* 1 (CSU); *8 1/2 mi. NE Fort Collins,* 1 (CSU); *7 mi. NW Fort Collins,* 1 (CSU); *5 mi. NE Fort Collins,* 1 (CSU); *4 mi. N, 11 mi. E Fort Collins,* 1 (CSU); *5 mi. SW Fort Collins,* 8 (CSU); *6 mi. SW Fort Collins,* 8 (CSU); *6 1/4 mi. S Fort Collins,* 1 (CSU); *7 mi. SW Fort Collins,* 7 (CSU); 7 1/2 mi. SW Fort Collins, 1 (CSU); *7 mi. S Fort Collins,* 1 (CSU); 7 mi. W Loveland, 2 (CSU); Loveland, 15 (1 ANSP, 1 CSU, 13 USNM). WELD COUNTY: E of Rockport, 1 (CU); 7 mi. E Pawnee Buttes, 2 (USNM); *9 mi. N Nunn,* 1 (CSU); 10 mi. NE Nunn, 1 (USNM); Horsetail Creek Fossil Camp, 17 mi. NW Stoneham, 11 (DMNH); *2 mi. N, 4 mi. E Nunn,* 1 (CSU); Central Plains Experimental Range, near Nunn, 14 (4 CU, 10 UNM); 18 mi. E Fort Collins, 1 (CSU); 1 mi. S, 10 mi. E Ault, 1 (CSU); 12 mi. NW New Raymer, 1 (CU); 15 mi. NE La Salle, 1 (CSU); Greeley, 1 (USNM); *SE of Kersey,* 1 (CSC); *3 mi. N Riverside Reservoir,* 1 (CSC); Riverside Reservoir, 3 mi. N Masters, 2 (CSC); Roggen, 1 (FMNH); 5 mi. SE Fort Lupton, 1 (CU). LOGAN COUNTY: 1 1/2 mi. S, 13 mi. W Peetz, 1 (KU); *2 1/2 mi. S, 12 mi. W Peetz,* 1 (KU); *10 mi. E Avalo,* 1 (USNM); *20 mi. E Avalo,* 3 (USNM); *7 mi. NW Crook,* 1 (WSC); 4 mi. E Crook, 1 (WSC); Sterling, 14 (2 DMNH, 12 USNM); 6 mi. N Merino, 1 (CSU); 6 mi. SE Sterling, 2 (USNM). SEDGWICK COUNTY: Julesburg, 2 (CSU). ADAMS COUNTY: 2 mi. E Brighton, 1 (KU); *Barr Lake,* 9 (DMNH); Barr, 4 (DMNH); 30 mi. S Fort Morgan, 1 (UMMZ); *Simpson,* 1 (DMNH); 25 mi. NE Deer Trail, 1 (CSU); *2 mi. N, 8 mi. E Derby,* 1 (DMNH); *Derby,* 2 (DMNH); *3 mi. N Fitzsimmons,* 2 (DMNH); *Fitzsimmons,* 2 (SC); Aurora, 3 (1 CU, 2 UNM); *1 mi. N, 6 mi. E Denver,* 1 (DMNH); *no locality other than county,* 1 (DMNH). DENVER COUNTY: Denver, 1 (CU). WASHINGTON COUNTY: *Eastern Colorado Range Experiment Station, 17 mi. S Sterling,* 4 (CSU); 15 mi. N Akron, 2 (CSU); Akron, 3 (UMMZ); 9 mi. N, 1/2 mi. E Cope, 1 (KU). YUMA COUNTY: *1/2 mi. N, 3 1/2 mi. W Wray,* 1 (KU); Wray, 5 (DMNH); *W end of Bonny Reservoir,* 20 (CU); *Bonny Reservoir,* 3 (UI); 1/2 mi. S, 2 mi. W Hale, 4 (KU). DOUGLAS COUNTY: Parker, 1 (DMNH). KIT CARSON COUNTY: Tuttle, 1 (USNM); 22 mi. NE Seibert, 1 (USNM); 4 mi. NE Burlington, 2 (KU); *4 mi. E Flagler,* 3 (KU); 4 1/2 mi. E Flagler, 9 (KU).

Additional record: LARIMER COUNTY: *4 mi. SW Fort Collins* (Reed, 1957:135).

Dipodomys ordii montanus Baird

Dipodomys montanus Baird, Proc. Acad. Nat. Sci. Philadelphia, 7:334, April 1855; type locality, Fort Massachusetts, Costilla Co., Colorado.

Dipodomys ordii montanus, Grinnell, Jour. Mamm., 2:96, 2 May 1921.

Distribution in Colorado.—San Luis Valley (Fig. 62).

Comparisons.—From *D. o. richardsoni,* the subspecies of southeastern Colorado, *D. o. montanus* differs in smaller external and cranial size and markedly darker color. From *D. o. evexus,* the subspecies of the Upper Arkansas Valley, *D. o. montanus* differs in generally smaller size externally, smaller cranial size in most measurements taken (greatest breadth across the bullae is consistently larger), and slightly darker color. Also, the ventral stripe of the tail is continuous with the hairs of the "pencil," a trait not typical of *D. o. evexus.*

Measurements.—Mean (and extreme) external measurements of 10 males, followed by those of six females, all from Alamosa and northern Costilla counties, are: 257.2 (240-280), 257.7 (242-270); 140.8 (130-150), 144.5 (134-155); 42.5 (40-43), 40.8 (40-43); 12.0 (10-15), 13.0 (13-13). Cranial measurements are presented in table 17.

Remarks.—The range of *D. o. montanus* is isolated from those of other subspecies of kangaroo rat in Colorado. Neither La Veta Pass nor Poncha Pass provides suitable habitat for arenicolous rodents. Intergradation of *D. o. montanus* with *D. o. ordii* and *D. o. richardsoni* takes place in northern New Mexico (Setzer, 1949:540).

Hall and Kelson (1959:516) gave the type locality of *D. o. montanus* as "Fort Massachusetts (now Fort Garland), Costilla Co., Colorado," perhaps following Miller and Kellogg (1955:399) or Merriam (1904:140). As noted by Setzer (1949:540), Fort Garland and Fort Massachusetts are two different former United States Army posts. Fort Massachusetts was located in sec. 14, T. 29 S, R. 112 W, some 6 mi. N of Fort Garland. The post was found to be vulnerable to attack and was abandoned in 1858. Fort Garland, located on the southern outskirts of the present-day town of that name, was built in 1858 to replace Fort Massachusetts.

An immature female (KU 59867) from 8 mi. S and 2 mi. E of Fort Garland is pale dorsally and on the plantar surfaces, and the dark stripes of the tail are gray rather than the black typical of *montanus.* Otherwise specimens examined of this richly colored race are remarkably homogeneous.

Records of occurrence.—Specimens examined, 210, distributed as follows: SAGUACHE COUNTY: 1 mi. N Saguache, 8000 ft., 1 (USNM); *Saguache,* 6 (1 DMNH, 1 USNM, 4 WC); Crestone, 7851 ft., 1 (WC); 5 mi. NW Hooper, 7 (1 AMNH, 6 DMNH); 9 mi. E Center, 1 (AMNH). RIO GRANDE COUNTY: 8 mi. S Monte Vista, 1 (UI). ALAMOSA COUNTY: *Hooper, 7566 ft.,* 1 (WC); *24 mi. E Hooper, 8300 ft.,* 1 (DMNH); *Great Sand Dunes National Monument,* 3 (2 CU, 1 GSDNM); *NE Alamosa County,* 3 (FWS); *Mosca Creek, 8200 ft.,* 1 (WC); Medano Ranch, 15 mi. NE Mosca, 3 (USNM); *San Luis Lakes,* 9 (5 KU, 4 WC); *12 8/10 mi. E junction Colorado highways 17 and 150,* 9 (UNM); *19 8/10 mi. E junction Colorado highways 17 and 150,* 56 (UNM); 22 mi. E Mosca, 5 (USNM); *6 mi. S, 3 mi. W Great Sand Dunes National Monument, 8000 ft.,* 1 (KU); *8 mi. S Great Sand Dunes National Monument,* 1 (ASC); Alamosa, 1 (UMMZ). CONEJOS COUNTY: Antonito, 1 (USNM); *7 mi. E Antonito,* 3 (USNM); 12 mi. E Antonito, 5 (USNM); *Conejos River,* 1 (USNM). COSTILLA COUNTY: 4 mi. N, 6 mi. W Blanca, 10 (KU); near Fort Massachusetts, 1 (USNM); *3 mi. NW Fort Garland,* 8 (DMNH); 15 mi. W Fort Garland, 7800 ft., 4 (KU); *Fort Garland,* 35 (10 UI, 25 USNM); *5 mi. SSW Fort Garland,* 1 (AMNH); *5 mi. SSE Fort Garland,* 10 (AMNH); *5 mi. S Fort Garland,* 3 (AMNH); 8 mi. S, 2 mi. E Fort Garland, 8000 ft., 1 (KU); San Acacio, 4 (WC); *2 1/2 mi. S San Acacio,* 5 (CSU);

Colorado Highway 159, 2 1/2 mi. N Colorado-New Mexico boundary, 7 (UNM); *San Luis Valley,* 2 (AMNH).

Additional records (Setzer, 1949:540, unless otherwise noted): ALAMOSA COUNTY: *1 6/10 mi. NE Headquarters, Medano Springs Ranch; 3 mi. S Great Sand Dunes National Monument.* COSTILLA COUNTY: *4 1/2 mi. N Blanca, 8100 ft.; 1 mi. NE Blanca, 7950 ft.; 1 mi. NE Fort Garland; near Blanca* (Longhurst, 1942:242).

Dipodomys ordii nexilis Goldman

Dipodomys ordii nexilis Goldman, Jour. Washington Acad. Sci., 23:470, 15 October 1933; type locality, 5 mi. W Naturita, Montrose Co., Colorado.

Distribution in Colorado.—Semiarid valleys of San Miguel and Dolores rivers, south of Uncompahgre Plateau (Fig. 62).

Comparisons.—From Coloradan specimens of *D. o. sanrafaeli,* the subspecies of the Grand Valley of the Colorado, specimens of *D. o. nexilis* differ in averaging larger cranially and slightly larger externally, and in darker dorsal color, the dorsal pelage being strongly suffused with black. For comparison with *D. o. longipes,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of 11 males, followed by those of four females, all from southwestern Montrose County, are: 269.6 (254-279), 265.7 (258-279); 148.5 (137-155), 148.0 (141-153); 45.3 (43-46), 44.5 (43-46). Selected cranial measurements are presented in table 17.

Remarks.—Setzer (1949:561) referred a single specimen from Hotchkiss (USNM 149942) to this subspecies. It is herein referred to *sanrafaeli* on geographic grounds. Probably the Uncompahgre Plateau is an absolute barrier to kangaroo rats and *nexilis* and *sanrafaeli* are not in contact in Colorado. Intergradation occurs in Grand County, Utah (Setzer, 1949:560).

Records of occurrence.—Specimens examined, 32, distributed as follows: MONTROSE COUNTY: *West Paradox Valley,* 1 (DMNH); Bedrock, 5750 ft., 10 (4 AMNH, 6 WC); 5 mi. W Naturita, 3 (USNM); Coventry, 6800 ft., 18 (4 AMNH, 2 USNM, 12 WC).

Dipodomys ordii priscus Hoffmeister

Dipodomys ordii priscus Hoffmeister, Proc. Biol. Soc. Washington, 55:167, 31 December 1942; type locality, Kinney Ranch, 21 mi. S Bitter Creek, 7100 ft., Sweetwater Co., Wyoming.

Distribution in Colorado. — In suitable habitat in northwestern part of state, generally north of White River, eastward at least to Lay (Fig. 62).

Comparisons.—From *D. o. sanrafaeli,* the subspecies of the Colorado River Valley to the south, *D. o. priscus* differs in less reddish dorsal color, longer nasals, less inflated auditory bullae, and incomplete ventral stripe of tail. From *D. o. uintensis,* a subspecies of the Uinta Basin in Utah, *D. o. priscus* differs in longer hind foot, darker color, and in cranial details (Setzer, 1949:525).

Measurements.—External measurements of a male (DMNH 2053) and mean (and extremes) of six females, all from Moffat County, are: 250, 255.8 (251-264); 140, 139.7 (135-148); 42, 41.2 (40-45). Cranial measurements are presented in table 17.

Remarks.—Intergradation between *D. o. priscus* and *D. o. sanrafaeli* is unknown in Colorado, and it is probable that the forested Roan Plateau is an absolute barrier between the two kinds in the state. According to Setzer (1949:548), *D. o. priscus* is not known to intergrade with any adjacent subspecies. The influence of *D. o. uintensis* in northwestern Colorado has not been observed but is probably to be expected.

Records of occurrence.—Specimens examined, 32, distributed as follows: MOFFAT COUNTY: [Little] Snake River, 20 mi. W Baggs, Wyoming, 4 (USNM); *[Little] Snake River, S of Sunny Peak,* 2 (USNM); 20 mi. NW Sunbeam, 7 (CM); *5 mi. W [Little] Snake River, 5900 ft.,* 1 (WC); Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 2 (DMNH); *[Little] Snake River, lower bridge,* 1 (WC); *[Little] Snake River,* 8 (DMNH); Sunbeam, 1 (CSU); Lay, 2 (USNM); N bank Yampa River, 5 mi. NW Cross Mountain, 1 (CM). RIO BLANCO COUNTY: *6 mi. N Rangely,* 1 (CM); W side White River, 5200 ft., 1 mi. N Rangely, 2 (CM).

Dipodomys ordii richardsoni (J. A. Allen)

Dipodops richardsoni J. A. Allen, Bull. Amer. Mus. Nat. Hist., 3:277, 30 June 1889; type locality restricted by Glass (1971:499) to sec. 32, T. 2 N, R. 2 E, Cimarron Meridian, Cimarron Co., Oklahoma.

Dipodomys ordii richardsoni, Grinnell, Jour. Mamm., 2:96, 2 May 1921.

Distribution in Colorado.—Plains of eastern part of state, generally the drainage of the Arkansas River (Fig. 62).

Comparisons.—For comparison with *D. o. montanus, D. o. luteolus,* and *D. o. evexus,* see accounts of those subspecies.

Measurements. — Average (and extreme) external measurements of 10 males, followed by those of four females, all from Beaver County, Oklahoma, are: 257.4 (243-272), 251.3 (246-255); 138.1 (124-148), 134.7 (133-136); 41.4 (40-45), 41.0 (41-43); 13.5 (13-14), 13.0 (13-13). Average (and extreme) external measurements of five males, followed by those of seven females, all from the vicinity of Lamar, are: 252.6 (244-271), 246.6 (242-250); 138.0 (134-147), 136.6 (133-141); 41.6 (41-42), 40.3 (40-41); 12.8 (12-13), 13.6 (13-15). Mean and extreme measurements of five males from the vicinity of Colorado Springs are: 257.4 (247-264); 137.6 (133-145); 41.2 (38-42). Those of six males from SE of Hasty, Bent County, are: 259.7 (254-268), 146.5 (139-152), 40.7 (39-41), 15.0 (14-16), weight, 71.98 (63.5-83.5). Representative cranial measurements appear in table 17.

Records of occurrence.—Specimens examined, 226, distributed as follows: LINCOLN COUNTY: Limon, 2 (USNM); Hugo, 2 (USNM); 1/4 mi. S, 6 mi. E Rush, 1 (FHSC). EL PASO COUNTY: *6 mi. N, 1 mi. W Colorado Springs,* 3 (UI); *3 mi. N Colorado Springs,* 2 (WC); *2 1/2 mi. N Colorado Springs,* 1 (WC); *N of Colorado Springs,* 1 (WC); Colorado Springs, 3 (2 AMNH, 1 MCZ); *2 mi. E Colorado Springs,* 4 (WC); 20 mi. S Colorado Springs, 1 (AMNH). CHEYENNE COUNTY: 2 mi. S Aroya, 1 (CSC); Cheyenne Wells, 1 (WC); 10 mi. S Firstview, 58 (CU); *"10-20 mi. S Firstview,"* 9 (CU). PUEBLO COUNTY: 6 mi. W Pueblo, 1 (CSU); *3 mi. W Pueblo,* 1 (WC); Pueblo, 1 (USNM); 4 8/10 mi. N Boone, 4800 ft., 1 (WSC); 17 mi. S Pueblo, 4600 ft., 1 (CSC). CROWLEY COUNTY: Sugar City, 1 (CU); Olney [Springs], 1 (USNM). KIOWA COUNTY: Chivington, 6 (USNM). HUERFANO COUNTY: Huerfano, 1 (USNM); 1 mi. W Gardner, 2 (DMNH); Colorado Highway 69, NW of Walsenburg, 2 (CU); 20 mi. E Walsenburg, 3 (DMNH). OTERO COUNTY: *4 mi. E Fowler,* 1 (CSU); 1/2 mi. S, 1/4 mi. W Manzanola, 1 (CSU); *4 mi. SE Fowler,* 2 (1 CSC, 1 CSU); 4 mi. S, 1 mi. E Fowler, 1 (CSU); *4 mi. S, 6 mi. E Fowler,* 1 (CSU); La Junta, 1 (USNM); JJ Ranch, Higbee, 5 (USNM). BENT COUNTY: 2 mi. S, 2 mi. E Hasty, 9 (KU); Rule Creek, 1 (FWS). PROWERS COUNTY: 2 mi. W Lamar, 1 (WC); *Lamar,* 1 (WC); *1 mi. S Lamar,* 12 (KU); *1 1/2 mi. S Lamar,* 1 (WC); 1 mi. N Two Buttes Reservoir, 4350 ft., 1 (KU). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 2 (WC); 3 1/2 mi. S, 5 mi. W Kim, 1 (KU); 1 mi. S, 7 mi. E Trinidad, 1 (KU); Trinchera, 8 (DMNH); *Cook Ranch, Hillside Spring* (not found), 3 (CSU). BACA COUNTY: *14 mi. N, 4 mi. E Springfield,* 4 (KU); Two Buttes, 6 (DMNH); 15 mi. NNW Springfield, 1 (CU); *Fred Gold Farm, 11 mi. N, 6 mi. W Springfield,* 4 (DMNH); *Williams' Corner, 11 mi. N Springfield,* 11 (DMNH); Monon, 9 (1 AMNH, 1 MCZ, 7 WC); *N of Springfield,* 5 (WC); Springfield, 4 (1 AMNH, 1 MCZ, 2 WC); *Carrizo Creek,* 5 (DMNH); Furnace [Furnish] Canyon, 1 (DMNH); *Jimmie Creek,* 8 (DMNH); Regnier, 4 (DMNH); Craugh Ranch, Cimarron River, 2 (DMNH).

Additional records: HUERFANO COUNTY: (Cary, 1911:140-141): Muddy Creek, 8 mi. W Gardner; *Gardner; Walsenburg;* La Veta.

Dipodomys ordii sanrafaeli
Durrant and Setzer

Dipodomys ordii sanrafaeli Durrant and Setzer, Bull. Univ. Utah, 35:26, 30 June 1945; type locality, 1 1/2 mi. N Price, 5567 ft., Carbon Co., Utah.

Distribution in Colorado. — Valleys of Colorado River and affluents (Fig. 62).

Comparisons.—For comparison with *D. o. priscus* and *D. o. nexilis,* see accounts of those subspecies.

Measurements.—Mean (and extreme) external measurements of five males from the vicinity of Grand Junction are: 261.4 (248-274); 145.0 (140-150); 43.2 (42-45); 12.7 (11-14). External measurements of two females from 8 mi. W of Olathe, Montrose County, are: 259, 254; 146, 144; 42, 43. Cranial measurements are presented in table 17.

Records of occurrence.—Specimens examined, 20, distributed as follows: MESA COUNTY: Stateline, 4 (CM); Fruita, 1 (USNM); *Airport, Grand Junction,* 2 (CU); *2 mi. W Grand Junction,* 2 (DMNH); *Colorado National Monument,* 3 (CU); Grand Junction, 4 (USNM); Picnic Area, Colorado National Monument, 1 (CNM). DELTA COUNTY: Hotchkiss, 1 (USNM). MONTROSE COUNTY: 8 mi. W Olathe, 2 (DMNH).

FAMILY CASTORIDAE—BEAVER

Castor canadensis

BEAVER

The beaver ranges state-wide in Colorado in suitable habitats. Areas of greatest abundance are those where streams have low grades and occupy broad valleys and where phreatophytic vegetation is abundant. Areas such as Taylor Park and North Park perennially support large populations. Retzer *et al.* (1956) investigated the influence of physical factors on suitability of sites for beavers. Where basic site qualities are suitable, beavers have a far-reaching effect on the environment, influencing the water-table and runoff, plant succession, and pedogenesis (see Neff, 1957).

The beaver is abundant in some parts of Colorado today, but in the late Nineteenth Century, populations were reduced by over-exploitation to dangerously low levels. From 1900 to 1955 only "nuisance beaver" were trapped. During that period, numbers increased on public lands to the point that habitats were degraded. The over-population in certain areas was reduced by epizootic tularemia in 1957-1958, but since 1960, populations have increased steadily. In the 12 trapping seasons between 1958 and 1969, annual harvest has increased from about 5700 to slightly over 10,000 animals. In 1957-1958, 85.6 per cent of the harvest was by state trappers, whereas in 1969, they took only 5.5 per cent of the harvest. As populations have increased, the numbers of animals trapped by landowners have increased tremendously (623 in 1958, 6705 in 1969, high of 7373 in 1964). There has been a concomitant decrease in numbers of transplants by state officials (655 in 1961, 129 in 1969—unpublished data from Division of Game, Fish and Parks).

The program of management of beaver in Colorado has shown excellent results and is based on thorough research. Some important reports resulting from such studies include Yeager and Hill (1954), Retzer *et al.* (1956), Yeager and Rutherford (1957), and Rutherford (1964). Yeager and Hay (1955) compiled an extensive bibliography on ecology and management of beaver.

The natural history of Coloradan beaver has been the subject of considerable popular and semitechnical literature. The most important of the early workers was Enos A. Mills, pioneer naturalist of the Longs Peak region. Observations on the so-called "Moraine Colony" on the Roaring Fork (of Cabin Creek) between 1885 and 1912 were described by Mills (1913), and that colony also was studied by Warren (1927c). Neff (1959) resurveyed the area in 1955. Packard (1940, 1941, 1947b) noted observations on beaver in Rocky Mountain National Park, and Wright *et al.* (1933) and Cahalane (1948) discussed the status of the beaver there.

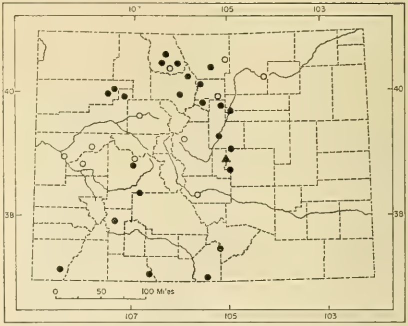


FIG. 63. Distribution of *Castor canadensis concisor* in Colorado. For explanation of symbols, see p. 9.

E. R. Warren made major contributions to the study of the natural history of the beaver, including local surveys (1926c, 1927c, 1928d, 1932d, 1932e), descriptions of lodges and dams (1905, 1932b, 1938), notes on preferences of plants for food and building material (1928c, 1940), and semitechnical accounts of natural history (1928a, 1938). His monographic study of the beaver (Warren, 1927b) is more anecdotal than analytic, but contains a considerable amount of information that still is useful, much of it based upon observations made in Colorado.

Castor canadensis concisor Warren and Hall

Castor canadensis concisor Warren and Hall, Jour. Mamm., 20:238, 14 August 1939; type locality, Monument Creek, SW of Monument, El Paso Co., Colorado.

Distribution in Colorado.—Statewide in suitable habitat (Fig. 63).

Measurements.—External measurements of a male and a female from southern Jackson County, a male and a female from Middle Park, and a male from the Navajo River, Archuleta County, are, respectively, 974, 1018, 982, 956, 1101; 286, 301, 298, 280, 397; 156, 170, 177, 170, 181; 34, 34, —, —, —.

Selected cranial measurements of the

above-mentioned individuals, followed by those of a male from near the type locality, include: condylobasal length, 121.6, 121.9, 126.7, 132.9, 123.2, 127.7; zygomatic breadth, 90.3, 94.6, 91.3, 99.1, 89.8, 91.0; length of diastema, 40.5, 42.9, 44.9, 43.9, 40.6, 43.6; interorbital constriction, 24.3, 24.1, 23.5, 23.8, 23.3, 23.4; length of nasals, 41.9, 43.8, 43.7, 44.0, 43.7, 47.0; length of maxillary toothrow, 28.0, 27.7, 27.2, 31.2, 31.9, 28.9. For additional measurements, see Warren and Hall (1939: 361).

Remarks. — All Coloradan beavers are herein referred tentatively to a single subspecies, following Warren (1942:185). This is done with considerable hestitation. Given the ecological and behavioral characteristics of beavers, I would suppose that micro-evolution in those animals would reflect—at least in a general way—hydrographic patterns. Most of the major drainage systems of the western United States are represented by a different nominal subspecies of *C. canadensis* (see Hall and Kelson, 1959:549). In Colorado, several master streams of the western part of the country head within a few miles of each other along the Continental Divide (see Fig. 3). To me, it seems incongruous that at their sources a number of drainages should share a common kind of beaver, whereas downstream each drainage has a distinct subspecies. In fact, the name *concisor* may pertain to animals in a broad area of intergradation between a number of generally distinctive geographic races. The high degree of variability seen in the limited material available would seem to support the notion of such a pattern of intergradation.

Several nominal subspecies might, on geographic grounds, be recognized in Colorado. *Castor c. missouriensis* is ascribed a range throughout the central and northern Great Plains. I have examined no specimens from the eastern plains where individuals assignable to that race might be expected. *Castor c. mexicanus* is the subspecies of the Rio Grande, *C. c. repentinus* occurs in the Colorado River drainage, and *C. c. duchesnei* was ascribed a range (Durrant, 1952:290) in the drainages of the White and Green rivers. Durrant and Crane (1948:416) considered animals from eastern Rio Blanco County to be intergrades between *duchesnei* and *concisor.* For comparisons of *C. c. concisor* with other nominal subspecies, see Warren and Hall (1939) and Durrant and Crane (1948).

A thorough study of geographic variation in *C. canadensis* would be of considerable interest. The influence of transplanting programs on distribution of the beaver and gene flow would be an important consideration in any such study.

Records of occurrence.—Specimens examined, 47, distributed as follows: JACKSON COUNTY: North Park, 2 (CSU); near Coalmont, 1 (CU); South Michigan River, 1 mi. W Gould, 8500 ft., 3 (KU). LARIMER COUNTY: Big Thompson River, 1 (RMNP); *Brinwood Meadows* (not found), 2 (RMNP). RIO BLANCO COUNTY: 9 1/2 mi. SW Pagoda Peak, 3 (KU); Buford, 1 (CU). GARFIELD COUNTY: Trappers Lake, 1 (KU). GRAND COUNTY: *Onahu Creek,* 1 (RMNP); *Grand River, 9500 ft.,* 5 (AMNH); Grand Lake, 2 (1 DMNH, 1 USNM); Scholl [near Parshall], 2 (DMNH). BOULDER COUNTY: *Mount Meeker,* 1 (AMNH); *no locality other than county,* 1 (CU). GILPIN COUNTY: Tolland, 1 (CU). JEFFERSON COUNTY: Arvada, 1 (CSU); *Lakewood,* 1 (CU); Deckers, 1 (CU). DENVER COUNTY: Denver City, 1 (USNM). GUNNISON COUNTY: Slate River, above Crested Butte, 9000 ft., 1 (WC); 11 mi. SSE Gunnison, 1 (FWS). EL PASO COUNTY: Palmer Lake Reservoir, 1 (USNM); Monument Creek, 6900 ft., 1 (WC); *Beaver Creek,* 1 (WC). HINSDALE COUNTY: 5 mi. S Lake City, 1 (KU). HUERFANO COUNTY: 4 mi. W La Veta, 4 (KU). MONTEZUMA COUNTY: Mancos River, 6200 ft., Mesa Verde National Park (cast of track), 1 (KU). ARCHULETA COUNTY: Navajo River, 4 (DMNH). COSTILLA COUNTY: Costilla River, 1 (USNM).

Additional records (Warren and Hall, 1939:362, unless otherwise noted): JACKSON COUNTY: within 7 mi. of Rand. LARIMER COUNTY: Poudre River, Bellvue to Windsor (Rutherford, 1953:261). WELD COUNTY: South Platte River, 2 mi. E Masters (Hay, 1957:268). EAGLE COUNTY: Snieve's Ranch, near Eagle (Grange, 1928:66). BOULDER COUNTY: South Fork Boulder Creek; *South Boulder Canyon* (Engle, 1924:202). MESA COUNTY: 9 mi. S, 3 mi. E Collbran, 10,200 ft. (Anderson, 1959a:411); Gunnison River, 4750 ft., 29 mi. NW Delta. PARK COUNTY: Montgomery (Blake and Blake, 1969:36). DELTA COUNTY: Dry Creek, 5300 ft., 7 mi. SW Cedaredge. GUNNISON COUNTY: ". . . along the East River from its source at least to Gothic" (Findley and Negus, 1953:238). EL PASO COUNTY: *Green Mountain Falls, Cascade Creek* (V. Bailey, 1927:20); Lake Moraine, 10,250 ft. FREMONT COUNTY: Arkansas River, 5 mi. W Texas Creek, (Warren, 1928c:253).

Family Cricetidae—Native Mice and Rats

Key to Species of Cricetidae in Colorado

1. Occlusal surface of cheekteeth having cusps 2
Occlusal surface of cheekteeth lacking cusps, but with lakes of dentine surrounded by enamel 11

2. Tail short, less than one-third total length; coronoid process of mandible notably high .... *Oynchomys leucogaster*
Tail not markedly short, greater than one-third total length; coronoid process of mandible not notably high 3

3. Faces of upper incisors grooved 4
Faces of upper incisors smooth 5

4. Dorsal caudal stripe narrow, about one-fourth diameter of tail; mid-dorsal stripe well defined; rostrum relatively short, condylobasal length 19.0 or less .... *Reithrodontomys montanus*
Dorsal caudal stripe relatively broad, about one-half diameter of tail; mid-dorsal stripe poorly defined; rostrum relatively long, condylobasal length 19 or greater .... *Reithrodontomys megalotis*

5. Pelage coarse, ears obscured in fur, hind foot greater than 28; supraorbital ridges prominent, condylobasal length greater than 32 .... *Sigmodon hispidus*
Pelage fine, ears prominent, hind foot less than 26; supraorbital ridges undeveloped; condylobasal length less than 30 6

6. Tail obviously shorter than head and body 7
Tail nearly as long or longer than head and body 8

7. Tail sharply bicolor, hind foot 21 or (usually) less; greatest length of skull less than 27 .... *Peromyscus maniculatus*
Tail not sharply bicolor, hind foot usually more than 21; greatest length of skull more than 27 .... *Peromyscus leucopus*

8. Ear relatively short, usually 20 or less .... *Peromyscus boylii*
Ear relatively long, 20 or more 9

9. Dorsal color bright buffy, usually with orangish pectoral patch; M1 and M2 without well-developed accessory tubercle between major outer cusps .... *Peromyscus crinitus*
Dorsal color not bright buffy, no orangish pectoral patch; M1 and M2 with accessory tubercle between major outer cusps 10

10. Ears longer than hind foot, color dirty buff; rostrum relatively short .... *Peromyscus truei*
Ears shorter than hind foot, color grayish; rostrum relatively long .... *Peromyscus difficilis*

11. Ears conspicuous, sparsely haired 12
Ears well haired, obscured in fur 18

12. Tail bushy, plantar surfaces furred from heel to proximal tubercle .... *Neotoma cinerea*
Tail not bushy, plantar surface furred only to heel 13

13. Nasal septum intact 14
Nasal septum broken by maxillovomerine notch 15

14. Dorsal color of adults gray, anterior palatine spine not bifurcate .... *Neotoma micropus*
Dorsal color of adults buffy, anterior palatine spine bifurcate .... *Neotoma floridana*

15. Anterior palatine spine stout, blunt .... *Neotoma lepida*
Anterior palatine spine pointed 16

16. Tail not sharply bicolor .... **Neotoma stephensi*
Tail sharply bicolor 17

17. Hairs over gular and pectoral regions white-based, no dark line about mouth; M1 with shallow anterointernal fold .... *Neotoma albigula*
Hairs over gular and pectoral regions mostly plumbeous-based, dark line about mouth; M1 with deep anterointernal fold .... *Neotoma mexicana*

18. Tail laterally flattened, scaly, sparsely haired; condylobasal length more than 60 .... *Ondatra zibethicus*
    Tail nearly terete, well-haired; condylobasal length less than 35 19
19. Cheekteeth rooted 20
    Cheekteeth evergrowing, not rooted 21
20. Dorsal color reddish; maxillary toothrow short, less than 5.5 .... *Clethrionomys gapperi*
    Dorsal color grayish brown; maxillary toothrow greater than 6.5 .... *Phenacomys intermedius*
21. Tail markedly short, but little longer than hind foot 22
    Tail medium to long, obviously longer than hind foot 23
22. Lower incisor lingual to entire mandibular toothrow; upper incisors grooved; condylobasal length greater than 28, zygomatic breadth greater than 17 .... **Synaptomys cooperi*
    Lower incisor labial to posterior molars; upper incisors not grooved; condylobasal length less than 26, zygomatic breadth less than 16 .. *Lagurus curtatus*
23. Tail usually one-third total length or greater .... *Microtus longicaudus*
    Tail usually one-fourth to one-third total length 24
24. Belly buffy; mammae six; M3 with four dentine lakes .... *Microtus ochrogaster*
    Belly white to silvery gray, not buffy; mammae four or eight; M3 with five dentine lakes 25
25. M2 with four dentine lakes and rounded posterior accessory loop .... *Microtus pennsylvanicus*
    M2 with four dentine lakes and lacking accessory loop 26
26. Mammae eight; incisive foramina narrow, constricted posteriorly .... *Microtus montanus*
    Mammae four, incisive foramina broad, truncate posteriorly .... *Microtus mexicanus*

Reithrodontomys montanus

PLAINS HARVEST MOUSE

Reithrodontomys montanus ranges throughout the central and southern Great Plains, southward to northern Durango. In Colorado, the species is known from localities widely scattered over the eastern plains and also by a single, problematic specimen thought to have been obtained in the San Luis Valley.

The plains harvest mouse occupies grassy uplands, sites generally more xeric that those utilized by *Reithrodontomys megalotis.* Hill and Hibbard (1943) contrasted habitat preferences of *R. montanus* and *R. megalotis* in southwestern Kansas, and Maxell and Brown (1968) described habitat differences in eastern Wyoming, but no study of the natural history of *R. montanus* in Colorado has been made. The plains harvest mouse is notably less well represented in collections than is *R. megalotis.* In part, this may reflect a differential abundance of the two species, but probably it also indicates the predilection for riparian communities of collectors working on the plains.

Superficially, *R. montanus* and *R. megalotis* may be difficult to distinguish. If adults are available, *montanus* contrasts with *megalotis* in: smaller external and cranial size; shorter, relatively broader, more robust rostrum; narrower, less inflated braincase; relatively shorter tail; narrower dorsal caudal stripe; and more or less pronounced mid-dorsal stripe. Identification of young *megalotis* may be difficult without comparative material, because allometric growth is such as to make skulls of young animals resemble those of *montanus* in conformation.

Reithrodontomys montanus albescens Cary

Reithrodontomys albescens Cary, Proc. Biol. Soc. Washington, 16:53, 6 May 1903; type locality, 18 mi. NW Kennedy, Cherry Co., Nebraska.

Reithrodontomys montanus albescens, Cary, N. Amer. Fauna, 33:110, 17 August 1911.

Distribution in Colorado.—Known from scattered localities on plains of eastern two-fifths of state (Fig. 64).

Comparison.—From *R. m. griseus,* the subspecies to the south and east, *R. m. albescens* differs in paler color and broader, generally heavier skull.

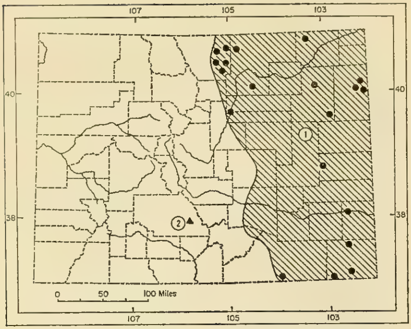


FIG. 64. Distribution of *Reithrodontomys montanus* in Colorado. 1. *R. m. albescens.* 2. *R. m. montanus.* For explanation of symbols, see p. 9.

Measurements.—External measurements of three males from eastern Yuma County, three young adult males from southern Washington County, and a male from northern Las Animas County are, respectively: 136, 132, 127, 119, 121, 111, 128; 67, 59, 53, 52, 58, 52, 62; 16, 17, 15, 17, 17, —, 16; 14, 13, 12, 16, 16, 14, 15; weights, 11.2, 12.9, 10.6, 9.9, —, 9.7, —. External measurements of a female from northern Logan County are: 122, 53, 16, 14. Representative cranial measurements are presented in table 18.

Remarks.—Smith (1964:19) tentatively maintained the subspecific status of *R. m. albescens*, but expressed the opinion that *albescens* and *montanus* may be found inseparable when adequate material is available from the western part of the range of the species. The pronounced differences between *albescens* and *montanus* noted by A. H. Howell (1914:22, 24) are artifactual, resulting from identification of a series of specimens from Medano Ranch, near San Luis Lakes, with *montanus*. Benson (1935a:141) correctly identified these specimens as *R. megalotis*. The population subsequently was recognized as a distinct subspecies, *Reithrodontomys megalotis caryi* by Howell (1935:143), but Jones and Mursaloglu (1961:19) considered *caryi* to be a synonym of the earlier-named *R. m. aztecus*.

Two males (skulls only, KU 116772-73) from Yuma County are larger externally and cranially than other specimens of *montanus* examined. The skulls are considerably shorter, however, than undoubted examples of *mega-*

TABLE 18

Selected cranial measurements of two species of *Reithrodontomys*.

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Cranial breadth	Interorbital constriction	Depth of skull	Length of maxillary toothrow
Reithrodontomys montanus albescens, eastern Yuma County							
KU 116772, ♂	20.8	19.1	10.9	10.5	3.2	7.8	3.3
KU 116773, ♂	20.6	18.9	10.9	10.5	3.4	8.2	3.2
KU 116774, ♂	19.9	18.3	10.7	9.9	3.0	7.8	3.6
Cope, Washington County							
KU 74686, ♂	19.6	18.1	—	9.2	3.0	7.4	3.4
KU 74693, ♂	19.6	18.0	10.2	9.3	2.9	7.4	3.4
KU 74697, ♂	19.4	17.8	10.2	9.7	3.1	7.5	3.4
3 mi. W Branson, Las Animas County							
KU 68481, ♂	19.8	18.6	10.6	9.8	2.9	7.5	3.3
Reithrodontomys megalotis aztecus, Huerfano County							
KU 121041, ♂	21.2	19.4	—	10.4	3.3	—	3.6
KU 121042, ♂	22.1	20.5	10.9	10.4	3.2	8.1	3.6
KU 121044, ♀	22.2	20.7	11.3	10.4	3.4	8.1	3.6
KU 121045, ♀	21.4	19.9	10.4	9.9	3.2	7.6	3.6
KU 121048, ♀	21.6	19.9	10.7	10.4	3.2	7.7	3.3

TABLE 18 (Continued)

Selected cranial measurements of two species of *Reithrodontomys.*

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Cranial breadth	Interorbital constriction	Depth of skull	Length of maxillary toothrow
Alamosa County							
Mean, 6 ♂	20.90	19.17	10.55	10.22	3.17	7.99	3.32
Minimum	19.4	18.0	10.4	9.9	3.0	7.4	3.2
Maximum	21.8	20.1	11.2	10.9	3.3	8.2	3.4
Mean, 5 ♀	20.72	18.93	10.54	10.06	3.08	7.72	3.26
Minimum	20.0	18.4	10.3	9.7	2.9	7.5	3.1
Maximum	21.6	19.7	11.0	10.4	3.2	8.4	3.4
eastern Montezuma County							
KU 69317, ♂	21.5	20.3	10.8	10.2	3.0	8.1	3.4
KU 69318, ♂	21.2	19.6	——	10.1	3.2	8.0	3.6
KU 75986, ♀	21.8	20.2	11.9	9.9	3.2	8.0	3.2
KU 79220, ♀	21.5	20.3	11.1	10.3	3.4	7.9	3.6
KU 102063, ♀	21.4	20.1	10.9	10.2	3.1	7.9	3.3
Reithrodontomys megalotis dychei, South Platte and Big Thompson valleys							
Mean, 10 ♂	21.96	20.42	10.89	10.28	3.41	8.11	3.21
Minimum	21.7	20.0	10.7	10.0	3.2	7.9	3.1
Maximum	22.5	20.9	11.1	10.4	3.5	8.3	3.3
Mean, 9 ♀	21.73	20.24	10.92	10.29	3.44	8.00	3.20
Minimum	21.1	20.0	10.7	10.1	3.2	7.9	3.0
Maximum	22.4	20.7	11.2	10.5	3.8	8.2	3.3
E of Flagler, Kit Carson County							
Mean, 10 ♂	21.67	20.12	10.95	10.44	3.19	8.11	3.39
Minimum	21.0	19.4	10.5	10.1	3.1	7.8	3.2
Maximum	22.4	20.7	11.3	10.7	3.3	8.5	3.5
Mean, 5 ♀	21.62	20.32	11.02	10.38	3.12	8.06	3.38
Minimum	20.8	19.6	10.7	10.1	3.1	7.9	3.1
Maximum	22.5	21.1	11.3	10.7	3.2	8.3	3.5
Reithrodontomys megalotis megalotis, western Moffat County							
KU 116788, ♂	20.6	19.0	10.7	10.4	3.2	8.1	3.3
KU 116789, ♂	21.6	19.6	11.0	10.6	3.3	7.9	3.4

lotis, and exhibit the short, robust rostrum characteristic of *montanus,* with which species they are here identified.

The color of Coloradan specimens is rather variable, but even in winter pelage seldom is as gray as in the population of the Sand Hills of Nebraska. On the other hand, Coloradan material does not approach the rich color of *R. m. griseus* from eastern Kansas and Nebraska.

Records of occurrence.—Specimens examined, 62, distributed as follows: LARIMER COUNTY: *Wellington Game Refuge,* 1 (CSU); 2 mi. E Wellington, 1 (CSU); *8 1/2 mi. NE Fort Collins,* 1 (CSU); 4 mi. N Bellvue, 1 (CSU); *5 mi. NE Bellvue,* 1 (CSU); *4 1/2 mi. NW Fort Collins,* 2 (CSU); *Watson Lake, 1/4 mi. NE Bellvue,* 2 (1 CSC, 1 CSU); *3 mi. NW Fort Collins,* 1 (CSU); *1 mi. N, 4 mi. W Fort Collins,* 1 (CSU); *5 mi. W Fort Collins,* 1 (CSU); *Fort Collins,* 1 (CSU); *1/4 mi. SW Fort Collins,* 1 (CSU); *1/2 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *W of College Lake, 5000 ft.,* 1 (CSU); *3 mi. S, 4 mi. W Fort Collins,* 2 (CSU); *6 mi. SW Fort Collins,* 1 (CSU); *Spring Canyon Dam,* 1 (CSU); *8 3/10 mi. SW Fort Collins,* 1 (CSU); 6 mi. S, 7 mi. W Fort Collins, 5600 ft., 1 (CSU); Fossil Creek Reservoir, 1 (CSU); Loveland, 1 (USNM); *no locality other than county,* 1

(CSU). WELD COUNTY: Central Plains Experiment Station, near Nunn, 1 (UNM); 8 mi. NE Hudson, 1 (CU). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU). DENVER COUNTY: Denver, 9 (AMNH). WASHINGTON COUNTY: Akron, 1 (UMMZ); Cope, 5 (KU). YUMA COUNTY: 10 mi. N Wray, 2 (DMNH); *1 mi. N, 3 1/2 mi. W Wray,* 1 (KU); 1/2 mi. N, 3 1/2 mi. W Wray, 1 (KU); 1 mi. W Laird, 1 (KU). CHEYENNE COUNTY: 1 mi. S Aroya, 1 (CSU). PROWERS COUNTY: Lamar, 1 (FWS). LAS ANIMAS COUNTY: 3 mi. W Branson, 1 (KU). BACA COUNTY: Two Buttes Creek, 14 mi. N Springfield, 1 (TCWC); *2 mi. E Campo,* 1 (AMNH); 3 mi. E Campo, 3 (AMNH); *West Furnace [Furnish] Canyon,* 1 (USNM); *Regnier,* 2 (DMNH); Three Corners, 2 (USNM).

Additional record: BACA COUNTY: Sand Canyon (F. W. Miller, 1928b:338).

Reithrodontomys montanus montanus (Baird)

Reithrodon montanus Baird, Proc. Acad. Nat. Sci. Philadelphia, 7:335, April 1855; type locality, upper part of San Luis Valley, Saguache Co., Colorado (see remarks).

Reithrodontomys montanus, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:80, 28 April 1893.

Distribution in Colorado.—Status uncertain; known presently in Colorado only by the holotype (Fig. 64).

Comparison.—From *R. m. griseus,* the subspecies of Texas, eastern New Mexico, and eastern Kansas and Nebraska, *R. m. montanus* differs in paler, more buffy color dorsally, less heavily washed with black, and paler (less blackish) ears and dorsal caudal stripe (after Hooper, 1952:39). For remarks on differences from *R. m. albescens,* see account of that subspecies.

Measurements.—Mean (and extreme) measurements of six individuals from Trans-Pecos Texas and adjacent New Mexico (Hooper, 1952:207, 210) are: 120 (114-130); 55 (48-63); 16 (15-17); 14 (13-16); greatest length of skull, 19.6 (19.1-20.1) zygomatic breadth, 10.1 (9.9-10.4); breadth of braincase, 9.0 (8.6-9.2); interorbital breadth, 2.8 (2.7-3.0); length of maxillary toothrow, 3.3 (3.2-3.5).

Remarks.—Baird (1855:335) described *R. montanus* on the basis of a single specimen collected by J. Creutzfeldt, botanist of Gunnison's ill-fated expedition of 1853-1854. Both Gunnison and Cruetzfeldt were killed by Utes in central Utah, and the few mammalian specimens obtained by the expedition were returned to the Smithsonian Institution by Captain E. G. Beckwith, who had assumed command (see Beckwith, 1855:71). The holotype of *R. montanus* (USNM 441/1306) bears the original number 13. Specimen number 11 of the expedition was collected near Fort Massachusetts (northwest of Fort Garland), specimen number 12 is lacking, and number 14 was obtained at Cochetopa Pass. In the original description of *R. montanus,* Baird indicated the type locality to be ". . . vicinity of the Rocky Mountains, lat. 38°." Later, Baird (1858:450) gave the type locality as "Rocky Mountains, 39°." The 39th parallel intersects the Rocky Mountains through the Rampart Range and the southern end of South Park, well to the north of Gunnison's route. The 38th parallel intersects the Wet Mountains and the northern part of the San Luis Valley. Inasmuch as this line lies near the route of the expedition from Fort Massachusetts to Cochetopa Pass, there seems no reason to consider the reference by Baird *(loc. cit.)* to 39° as anything but a *lapsus.* The type locality may be considered to be ". . . probably near the upper end of the San Luis Valley . . . ," Saguache County, following J. A. Allen (1895a:124). A. H. Howell (1914:25) also remarked on the type locality, restricting it to "near San Luis Lakes." Warren (1942:195) thought the type locality to be "very probably on Medano Creek, in Costilla County [since 1913, Alamosa County]." Both of the latter restrictions of the type locality probably were influenced by the collection of supposed "topotypical" *montanus* at Medano Ranch, NE of Mosca, by Cary in 1907; these specimens now are considered to represent *R. megalotis* (see Benson, 1935a).

Reithrodontomys montanus has had a checkered taxonomic history, reviewed in some detail by Benson (1935a) and also by Hooper (1952:34). More recently, J. D. Smith (1964) reviewed the problem in conjunction with a study of geographic variation in the plains harvest mouse throughout its known range. He attempted, as had others previously, to secure topotypes of this harvest mouse, working in the area of Costilla and Alamosa counties west and north of Blanca Peak, but was unsuccessful and concluded that ". . . it seems probable that adverse conditions eliminated *[montanus]* from the valley" (*op. cit.* :31). While that may, in fact, be the case, I do not believe that mammalogical reconnaissance of the northern part of the San Luis Valley has been sufficiently thorough to warrant any undue confidence in negative evidence. That part of Saguache County bounded by a line connecting Hooper, La Garita, Saguache, and Mineral Hot Springs is virtually unknown, and provides an abundance of habitat seemingly suitable for the species.

Records of occurrence.—Specimens examined, 1, as follows: SAGUACHE COUNTY: Rocky Mountains, 38°, 1 (USNM).

Reithrodontomys megalotis

WESTERN HARVEST MOUSE

The western harvest mouse occurs from the northern Great Plains and the Columbia Plateau southward to the Isthmus of Tehuantepec. The species is widespread in Colorado at lower elevations and may be abundant locally. *Reithrodontomys megalotis* is sympatric with *Reithrodontomys montanus* over parts of its range in Colorado. Typical habitat of the western harvest mouse in eastern Colorado is rank vegetation of flood plains and segetal communities in disturbed situations—roadsides, fencerows, and abandoned fields. Such disturbed areas also are occupied by the house mouse at some localities. In western Colorado, rougher, more xeric areas may be utilized. In western Moffat County, I have captured individuals in sparse, dry grass and Russian thistle on a bench above the Yampa River. In eastern Colorado, a site with comparable cover probably would be occupied by *R. montanus.*

A study of the ecology of the western harvest mouse in Colorado is needed. The relationship between the native harvest mouse and the adventive, commensal house mouse would be an interesting facet of such a study. Jones and Mursaloglu (1961:23) noted that the subspecies *R. m. dychei* probably has extended its range with the advent of irrigation, an observation that applies, to a lesser extent, to other Coloradan subspecies of *megalotis.* For brief comments on reproduction of Coloradan harvest mice, see Beidleman (1954) and Long (1962).

Jones and Mursaloglu (1961) studied geographic variation in *R. megalotis* in the central Great Plains, and their arrangement of subspecies is generally followed herein.

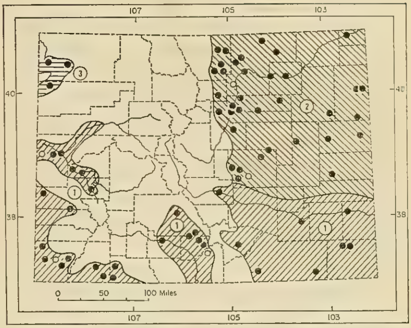


FIG. 65. Distribution of *Reithrodontomys megalotis* in Colorado. 1. *R. m. aztecus.* 2. *R. m. dychei.* 3. *R. m. megalotis.* For explanation of symbols, see p. 9.

Reithrodontomys megalotis aztecus
J. A. Allen

Reithrodontomys aztecus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:79, 28 April 1893; type locality, La Plata, San Juan Co., New Mexico.

Reithrodontomys megalotis aztecus, A. H. Howell, N. Amer. Fauna, 36:30, 5 June 1914.

Reithrodontomys megalotis caryi A. H. Howell, Jour. Mamm., 16:143, 15 May 1935; type locality, Medano Ranch, 15 mi. NE Mosca, Alamosa Co., Colorado (regarded as inseparable from *R. m. aztecus* by Jones and Mursaloglu, 1961:19).

Distribution in Colorado.—Southeastern part of the state, San Luis Valley, and western valleys south of Book Cliffs and Roan Plateau (Fig. 65).

Comparisons.—From *R. m. dychei,* the subspecies of northeastern Colorado and adjacent areas, *R. m. aztecus* differs in generally paler color (less heavily washed with black), longer tail and ear, and longer, relatively narrower rostrum. For detailed comparison, see Jones and Mursaloglu (1961:22). For comparison with *R. m. megalotis,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of six males, followed by those of five females, all from Alamosa County, are: 128.2 (117-142), 128.0 (118-142); 58.3 (52-69), 57.4 (50-64); 16.5 (16-17), 15.8

(15-17); 13.8 (12-15), 13.4 (12-14); a male weighed 9.1, three females, 8.9, 9.1, 9.5. External measurements of two males and three females from Montezuma County are, respectively: 146, 140, 155, 150, 133; 68, 65, 70, 79, 63; 17, 16, 18, 18, 17; 15, 15, 14, 17, 15. External measurements of two males and three females from Huerfano County are: 146, 148, 150, 141, 146; 69, 71, 72, 66, 72; 17, 18, 19, 18, 16; 15, 14, 16, 16, 15; weights, 13.8, 13.6, 14.9, 15.2, —. Representative cranial measurements are presented in table 18.

Remarks.—Jones and Mursaloglu (1961) reviewed the status of *R. m. caryi* A. H. Howell, concluding that western harvest mice of the San Luis Valley are intergrades between *R. m. aztecus* and *R. m. dychei,* although more closely resembling the former race. Specimens from southeastern Colorado are few but apparently also are intergrades between *aztecus* and *dychei.*

Records of occurrence.—Specimens examined, 165, distributed as follows: GARFIELD COUNTY: 7 mi. W Rifle, 5300 ft., 2 (USNM). MESA COUNTY: *2 mi. W Grand Junction,* 1 (DMNH); Grand Junction, 26 (USNM); Colorado National Monument, 1 (CU). DELTA COUNTY: 24 mi. S[E] Grand Junction, 1 (CU); Delta, 1 (DMNH). MONTROSE COUNTY: Montrose, 1 (DMNH); 2 mi. E Paradox, 1 (DMNH); Coventry, 1 (WC). SAGUACHE COUNTY: 10 mi. S Saguache, 1 (FWS); 5 mi. NW Hooper, 10 (DMNH); 9 mi. E Center, 19 (AMNH). FREMONT COUNTY: Cañon City, 6 (USNM). RIO GRANDE COUNTY: Del Norte, 1 (USNM). ALAMOSA COUNTY: Medano Ranch, 15 mi. NE Mosca, 18 (USNM); *San Luis Lake, 7550 ft.,* 1 (KU); *3 mi. S Great Sand Dunes National Monument,* 1 (GSDNM); 6 mi. S, 3 mi. W Great Sand Dunes National Monument, 2 (KU); *1/2 mi. S Uracca [Verracca] Pioneer Cemetery,* 3 (KU). HUERFANO COUNTY: *Walsenburg,* 2 (DMNH); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 8 (KU). OTERO COUNTY: La Junta, 1 (DMNH). PROWERS COUNTY: Lamar, 2 (KU). MONTEZUMA COUNTY: Ackmen, 1 (FMNH); Ashbaugh's Ranch [Moqui], 2 (USNM); 1 mi. W Mancos, 5 (KU); *N end Mesa Verde National Park, 7000 ft.,* 3 (KU); *Park Point, 8525 ft.,* 2 (KU); *Far View Ruins, 7700 ft.,* 3 (KU); *3 mi. N Rock Springs, 8200 ft.,* 2 (KU); *2 mi. NNW Rock Springs, 7900 ft.,* 2 (KU); *1 mi. NNW Rock Springs, 7600 ft.,* 1 (KU); 1/2 mi. NNW Rock Springs, 7500 ft., 1 (KU). LA PLATA COUNTY: 1 mi. NW Florida, 6700 ft., 1 (KU); *Florida, 6800 ft.,* 1 (KU); Allison, 4 (UNM). ARCHULETA COUNTY: 1 mi. S, 1 1/2 mi. E Chimney Rock, 1 (UNM); *6 mi. S, 1/2 mi. W Chimney Rock,* 2 (UNM); *1/5 mi. N, 1 mi. E Arboles,* 1 (UNM); Arboles, 1 (USNM); NE 1/4, SE 1/4 sec. 18, T. 32 N, R. 4 W, 6 (UNM); NW 1/4 sec. 23, T. 32 N, R. 6 W, 1 (UNM). LAS ANIMAS COUNTY: Trinidad, 1 (DMNH); 3 1/2 mi. S, 5 mi. W Kim, 1 (KU). BACA COUNTY: *14 mi. N, 4 mi. E Springfield,* 1 (KU); Fred Gold Farm, 11 mi. N, 6 mi. W Springfield, 6 (DMNH); Williams' Corner, 11 mi. N Springfield, 8 (DMNH).

Additional records: MESA COUNTY (P. H. Miller, 1964:61): *below Fruita Reservoir; utility area, Colorado National Monument, 5787 ft.; mouth of Monument Canyon, 4700 ft.; head of Ute Canyon, 6500 ft.; East Entrance Ranger Station, 4913 ft.; Upper Fruita Canyon Tunnel, 5250 ft.;* Sieber Ranch, Little Dolores River. MONTEZUMA COUNTY: Cortez (A. H. Howell, 1914:30). COSTILLA COUNTY: near Blanca (Longhurst, 1942:55).

Reithrodontomys megalotis dychei J. A. Allen

Reithrodontomys dychei J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:120, 21 May 1895; type locality, Lawrence, Douglas Co., Kansas.

Reithrodontomys megalotis dychei, A. H. Howell, N. Amer. Fauna, 36:30, 5 June 1914.

Distribution in Colorado.—Plains of northeastern and east-central parts of state (Fig. 65).

Comparison.—For comparison with *R. m. aztecus,* see account of that subspecies.

Measurements.—Average (and extreme) external measurements of nine males, followed by those of five females, all from the valleys of the Big Thompson and South Platte rivers, are: 139.5 (136-143), 144.8 (141-152); 66.7 (63-70), 70.2 (65-74); 17.7 (17-21), 16.5 (16-17); 15.0 (13-17), 14.4 (13-16); weights, 14.19 (12.9-15.9), 16.08 (12.0-21.0). Mean (and extreme) external measurements of 11 males, followed by those of five females, all from 4 mi. E of Flagler, Kit Carson County, are: 142.3 (131-152), 146.0 (134-154); 68.5 (64-80), 69.2 (66-75); 17.0 (16-18), 17.0 (16-18); 14.2 (13-15, 13.8 (13-15); weight, 13.29 (11.0-16.0), 13.65 (13.0-14.7). Selected cranial measurements are given in table 18.

Remarks.—Superimposed upon the pattern of geographic variation in size that defines subspecies of *R. megalotis* on the central plains is a pattern of apparently clinal variation in color. Specimens collected in late July in the lower Big Thompson Canyon (southeastern Larimer County) are considerably paler—more uniformly grayish brown and less heavily washed with black—than individuals from northwestern Kansas (Cheyenne and Rawlins counties). Series from east of Flagler and from northwest of Fort Morgan generally are intermediate in color between the abovementioned two populations. For detailed remarks on geographic variation and relationships between *dychei* and *aztecus,* see Jones and Mursaloglu (1961).

Records of occurrence.—Specimens examined, 217, distributed as follows: LARIMER COUNTY: 7 mi. N, 8 mi. W Fort Collins, 7600 ft., 1 (CSU); 2 mi. E Wellington, 1 (CSU); *4 mi. N Bellvue,* 1 (CSU); Watson Lake, 1 (CSU); *3/4 mi. S Bellvue,* 1 (CSU); *2 mi. W Fort Collins,* 1 (CSU); *1/2 mi. E Fort Collins,* 1 (CSU); *1 mi. E Fort Collins,* 1 (CSU); *NW 1/4 sec. 18, T. 7 N, R. 68 W, 4950 ft.,* 1 (CSC); *1/4 mi. N Horsetooth Dam,* 1 (CSU); 5 1/2 mi. SW Fort Collins, 1 (CSU); *2/10 mi. S Horsetooth Reservoir,* 1 (CSU); *Fossil Creek Reservoir,* 6 (CSU); *7 mi. NE Loveland,* 1 (CSU); *3 mi. N Loveland,* 1 (KU); *1/2 mi. N, 9 1/2 mi. W Loveland, 5600 ft.,* 1 (KU); 16 mi. W Loveland, 6840 ft., 1 (KU); *3 1/2 mi. W Loveland, 5030 ft.,* 7 (KU); Loveland, 5 (USNM); *1/2 mi. S, 6 mi. W Loveland, 5200 ft.,* 19 (KU); *2 1/2 mi. S, 7 mi. W Loveland, 5350 ft.,* 1 (KU); *1 mi. N Carter Lake,* 1 (CU). WELD COUNTY: Grover, 1 (DMNH); 12 mi. NW New Raymer, 4 (CU); 3 mi. N, 19 mi. E Fort Collins, 1 (CSU); 10 mi. SE Fort Collins, 1 (CSU); Greeley, 1 (USNM). MORGAN COUNTY: 4 mi. W Orchard, 1 (UMMZ); Muir Springs, 2 mi. N, 2 1/2 mi. W Fort Morgan, 21 (KU). SEDGWICK COUNTY: 5 mi. SW Julesburg, 4 (DMNH). BOULDER COUNTY: Valmont, 1 (USNM); *Boulder,* 4 (2 CU, 2 USNM); *Skunk Canyon, S of Boulder,* 1 (CU); *SW of Boulder,* 2 (CU); Mount Sanitas, 3 (CU). JEFFERSON COUNTY: Golden, 2 (USNM). ADAMS COUNTY: *Croke's Lake,* 4 (DMNH); Barr, 2 (WC); South Platte River, 5 mi. N Denver, 1 (KU); 3 mi. S, 1 mi. W Simpson, 1 (KU); *South Platte River at Sand Creek,* 1 (DMNH); *Clear Creek at Washington Street,* 3 (DMNH); *Clear Creek,* 2 (DMNH); 10 mi. E Denver, 1 (DMNH); Bennett, 8 (DMNH). DENVER COUNTY: Denver, 16 (14 DMNH, 2 USNM); *Argo,* 2 (DMNH). WASHINGTON COUNTY: Cope, 6 (KU). YUMA COUNTY: Wray, 8 (4 DMNH, 4 WC); 1 mi. E Laird, 1 (KU); *Bonny Reservoir,* 10 (UI); *W end Bonny Reservoir,* 1 (CU); *1 mi. S, 3 mi. W Hale,* 3 (KU); 1 mi. S, 2 mi. W Hale, 1 (KU). DOUGLAS COUNTY: Daniel's Park, 2 (DMNH). LINCOLN COUNTY: Limon, 4 (UMMZ). KIT CARSON COUNTY: 4 mi. NE Burlington, 5 (KU); *3 mi. NE Burlington,* 2 (KU); 4 mi. E Flagler, 12 (KU); *4 1/2 mi. E Flagler,* 6 (KU). EL PASO COUNTY: 2 mi. W Ramah, 2 (KU); 5 mi. E Peyton, 1 (KU); Manitou, 1 (UMMZ); 3 mi. E Colorado Springs, 7 (UI); 4 mi. S main gate, Camp Carson, 1 (KU). CHEYENNE COUNTY: 5 mi. S, 4 1/2 mi. W Kit Carson, 1 (FWS).

Additional records: WELD COUNTY: St. Vrain River, 1 mi. S, 6 mi. W Platteville (Archibold, 1964: 44). EL PASO COUNTY: 14 mi. E Fountain (Norris and Banta, 1965:55).

Reithrodontomys megalotis megalotis (Baird)

Reithrodon megalotis Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):451, 14 July 1858; type locality, between Janos, Chihuahua, and San Luis Springs, Grant Co., New Mexico.

Reithrodontomys megalotis, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:79, 28 April 1893.

Distribution in Colorado.—Lower valleys of White and Yampa-Green rivers, western Moffat and Rio Blanco counties (Fig. 65).

Comparison.—From *R. m. aztecus,* the subspecies of southern Colorado, *R. m. megalotis* differs in smaller external and cranial size and (in Colorado) in slightly paler color.

Measurements.—External measurements of two young adult males from western Moffat County are: 125, 133; 59, 59; 16, 17; 11, 13; weights, 10.8, 12.1. Cranial measurements are given in table 18.

Remarks.—Durrant (1952:297) considered specimens from east of the Green River and west of the Colorado River in east-central Utah to be intergrades between *R. m. megalotis* and *R. m. aztecus,* approaching the latter in color, but referable to the former race on the basis of cranial details. The few specimens available from northwestern Colorado clearly are referable to *R. m. megalotis.* In their pinkish buff (rather than yellowish buff) dorsal color, they are closer to specimens from Washington County, Utah, than to the population (of *aztecus*) of Montezuma County, Colorado. Nominotypical *megalotis,* as currently understood, is a wide-ranging subspecies. In the northern Great Basin, individuals are predominantly rich blackish brown in color; in the western Great Basin (western Nevada), they are blackish gray. In the "type region" in southern New Mexico and adjacent Mexico, populations tend to be pallid ashy gray, but farther south (Durango and Zacatecas) darker pelage again prevails.

Records of occurrence.—Specimens examined, 5, distributed as follows: MOFFAT COUNTY: Echo Park, 10 mi. N Artesia [Dinosaur], 5100 ft., 2 (KU); N bank Yampa River, 5 mi. NW Cross Mountain, 2 (CM). RIO BLANCO COUNTY: 6 mi. N Rangely, 1 (CM).

Peromyscus crinitus
CANYON MOUSE

Peromyscus crinitus occurs among rocks in warm, dry canyons of western Colorado at

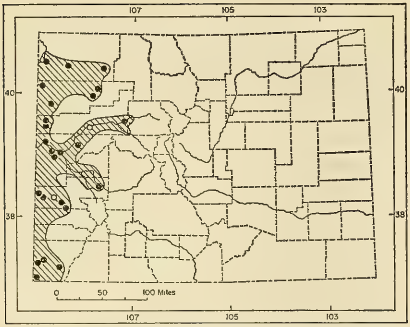


FIG. 66. Distribution of *Peromyscus crinitus auripectus* in Colorado. For explanation of symbols, see p. 9.

elevations up to about 8000 feet. Little is known of the natural history of the species in Colorado. Geographic variation in *P. crinitus* was studied by Hall and Hoffmeister (1942) and by Goin (1944). Brown and Welser (1968) studied serum albumin polymorphisms in canyon mice, including a sample from southwestern Colorado.

Peromyscus crinitus auripectus (J. A. Allen)

Sitomys auripectus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:75, 28 April 1893; type locality, Bluff City, San Juan Co., Utah.

Peromyscus crinitus auripectus, Osgood, N. Amer. Fauna, 28:231, 17 April 1909.

Distribution in Colorado.—Canyons of western part of state, eastward in Grand Valley to Glenwood Canyon (Fig. 66).

Comparison.—From *P. c. doutti*, the subspecies of Utah west of the Green River, *P. c. auripectus* differs in usually possessing a buffy pectoral spot and duller coloration (Goin, 1944:189).

Measurements.—Mean (and extreme) external measurements of five males from western Moffat and Rio Blanco counties, followed by those of eight females from Mesa, Montrose, and Montezuma counties, are: 174.0 (165-178), 178.5 (168-185); 89.8 (84-95), 94.9 (92-100); 21.6 (21-22), 21.9 (20-22); —, 20.8 (20-22); two males weighed 17.8 and 16.7; mean weight of five females was 17.52 (14.7-22.9). Selected cranial measurements are presented in table 20.

Remarks.—All specimens of *P. crinitus* from Colorado examined by me clearly are referable to the subspecies *P. c. auripectus*. Specimens of the canyon mouse are not available from that part of Moffat County that lies west of the Green River, but *P. c. doutti* may be expected to occur there.

Records of occurrence.—Specimens examined, 123, distributed as follows: MOFFAT COUNTY: above Castle Park, Dinosaur National Monument, 3 (CU); *Mantle's Cave, Dinosaur National Monument*, 1 (CU); *Hell's Canyon, Dinosaur National Monument*, 2 (CU); *Echo Park, 10 mi. N Artesia [Dinosaur]*, 3 (KU); Lily, 1 (DMNH); 8 mi. S, 4 mi. W Craig, 6400 ft., 1 (KU); *Yampa River, 5 mi. NW Cross Mountain*, 1 (CM); *S bank of Yampa River, 4 mi. NNW Cross Mountain*, 12 (CM). RIO BLANCO COUNTY: 5 mi. N, 10 mi. W Rangely, 4 (KU); 6 mi. NE Meeker, 7 (CM); Grand Hogback, 5 mi. S Meeker, 2 (CM); Douglas Creek, 19 mi. S Rangely, 1 (CM). GARFIELD COUNTY: Atchee, 1 (WC); 12 mi. above Glenwood Springs, 1 (WC); 20 mi. N Mack, 5 (CM). MESA COUNTY: Mack, 1 (WC); Plateau Creek, 5 mi. E Tunnel, 1 (USNM); Grand Junction, 4600 ft., 13 (2 FMNH, 1 MCZ, 1 USNM, 9 WC); Fruita Canyon, Colorado National Monument, 3 (CU); *100 yards SE Saddlehorn, Colorado National Monument*, 1 (CNM); *Headquarters, Colorado National Monument*, 1 (CNM); *Warehouse, Colorado National Monument*, 1 (CU); above Coke Ovens, Colorado National Monument, 3 (CU). MONTROSE COUNTY: South Rim Headquarters, Black Canyon of the Gunnison National Monument, about 8000 ft., 3 (CU); La Sal Creek Canyon, Paradox, 1 (CU); Bedrock, 5150 ft., 6 (2 AMNH, 4 WC); 1 mi. E Naturita, 5900 ft., 3 (KU); Coventry, 6800 ft., 5 (2 AMNH, 2 USNM, 1 WC). SAN MIGUEL COUNTY: *near Coventry, 6800 ft.*, 4 (3 AMNH, 1 WC). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 5350 ft., 11 (3 AMNH, 1 CSU, 2 USNM, 5 WC); *1 mi. S, 22 mi. W Cortez, 5000 ft.*, 1 (KU); 2 mi. S, 24 mi. W Cortez, 5000 ft., 3 (KU); Mesa Verde, 1 (USNM); *Balcony House, Mesa Verde National Park*, 3 (DMNH); *17 mi. S, 6 mi. E Cortez, 5600 ft.*, 2 (KU); Four Corners, 11 (DMNH).

Additional records: GARFIELD COUNTY: 8 mi. W Rifle (Hall and Hoffmeister, 1942:65). MESA COUNTY (P. H. Miller, 1964:63): *head of Monument Canyon, 5790 ft.; Rimrock Drive at Distant View, Colorado National Monument.* MONTROSE COUNTY: 4 mi. SE Uravan (Brown and Welser, 1968:421).

Peromyscus maniculatus

DEER MOUSE

The deer mouse is virtually ubiquitous in Colorado, ranging from low valleys of the eastern plains to alpine situations in the highest mountains, and from deserts and semideserts to lush subalpine meadows and dense forest. *Peromyscus maniculatus* is the most abundant of Coloradan mammals and has been the subject of considerable specialized research. Dice (1933, 1935a, 1935b) studied distribution and geographic variation of Coloradan deer mice in addition to laboratory study of individual variation and genetics.

Reproduction of the deer mouse in Colorado was discussed by Beidleman (1954) and Reed (1955), and Spencer and Steinhoff (1968) studied geographic variation in litter size. Catlett and Brown (1961) studied populations of *P. maniculatus* in Gunnison County, and Williams (1955a) and Finney (1962) investigated population densities in Gilpin County. Hematological studies comparing Coloradan deer mice with a population from northern Louisiana were reported by Gough and Kilgore (1964). Brown and Welser (1968) discussed polymorphism in serum albumin.

Beck (1966) reported on fleas of *P. maniculatus* in Mesa Verde National Park, and Kinsella (1968) recorded fleas from the species on Niwot Ridge, Boulder County. (Duszynski and Howkins (1968), Stock (1962), Dyer and Olsen (1967), and Dyer (1969) discussed endoparasites of Coloradan deer mice. Williams (1959a) and Williams and Finney (1964) reported on food habits of deer mice in Boulder and Gilpin counties, and Williams (1959b) reported on water uptake in captive deer mice.

Svihla (1932) compared life histories of Coloradan deer mice and piñon mice. Douglas' (1969b) study is the most thorough made to date on *P. maniculatus* in Colorado, contrasting that species with *P. truei* in Mesa Verde National Park.

Peromyscus maniculatus luteus Osgood

Peromyscus luteus Osgood, Proc. Biol. Soc. Washington, 18:77, 21 February 1905; type locality, Kennedy, Cherry Co., Nebraska.

Peromyscus maniculatus luteus, Osgood, N. Amer. Fauna, 28:77, 17 April 1909.

Distribution in Colorado.—Extreme eastern part of state (Fig. 67).

Comparison.—From *P. m. nebrascensis*, geographically adjacent to the west, *P. m. luteus* differs in smaller size, both externally and cranially, and in paler color (more yellowish buff, less grayish brown).

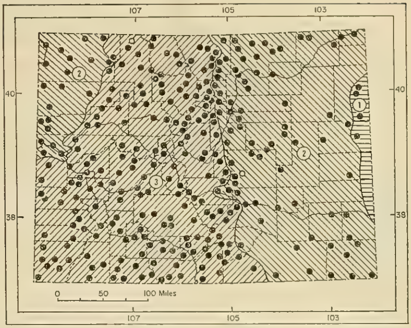


FIG. 67. Distribution of *Peromyscus maniculatus* in Colorado. 1. *P. m. luteus*. 2. *P. m. nebrascensis*. 3. *P. m. rufinus*. For explanation of symbols, see p. 9.

Measurements.—Mean (and extreme) external measurements of six males, followed by those of 10 females, all from eastern Yuma County, are: 152.8 (145-159), 152.3 (138-167); 63.2 (59-67), 62.6 (57-66); 18.8 (17-20), 19.0 (18-20); 15.0 (14-16), 15.8 (14-17); weight, 19.21 (17.1-23.1), 19.34 (14.0-22.5). For selected cranial measurements, see table 19.

Remarks.—Osgood (1909:79) referred specimens from Spring Canyon, southwest of Fort Collins, to this subspecies. Those specimens and others from the immediate vicinity of Fort Collins are herein referred to *P. m. nebrascensis*. Deer mice from eastern Colorado first were referred to the race now known as *P. m. luteus* by Jones and Loomis (1954). In general, individuals from the upper reaches of the Arikaree and Republican rivers closely resemble topotypes of *luteus* in color and also approach the small size of that race. Coloradan specimens average larger than topotypical *luteus* and represent intergrades between that race and *P. m. nebrascensis*. Jones (1964:205) observed a comparable pattern of intergradation in mice from adjacent Dundy County, Nebraska.

To the north, in the South Platte drainage, and to the south, in the Arkansas watershed,

TABLE 19

Selected cranial measurements of three subspecies of *Peromyscus maniculatus.*

Number averaged, sex	Greatest length of skull	Condylo-basal length	Zygomatic breadth	Inter-orbital constriction	Depth of skull	Length of nasals	Length of maxillary toothrow
Peromyscus maniculatus luteus, eastern Yuma County							
Mean, 6 ♂	24.80	23.48	12.73	3.82	9.00	10.00	3.78
Minimum	24.4	23.1	12.2	3.7	8.8	9.5	3.5
Maximum	25.9	24.1	13.0	3.9	9.2	10.7	4.0
Mean, 10 ♀	24.47	23.14	12.89	3.90	8.94	9.65	3.77
Minimum	23.3	22.0	11.9	3.5	8.6	8.8	3.6
Maximum	25.2	24.2	13.7	4.1	9.2	10.2	3.9
Peromyscus maniculatus nebrascensis, Larimer County, below 6000 feet							
Mean, 11 ♂	25.68	24.58	13.32	4.07	9.37	10.51	3.74
Minimum	24.9	23.9	12.8	3.8	9.0	9.2	3.4
Maximum	26.4	25.2	13.7	4.3	9.7	11.3	4.0
Mean, 7 ♀	25.65	24.45	13.30	4.01	9.32	10.52	3.75
Minimum	25.3	24.2	12.7	3.9	8.7	9.3	3.4
Maximum	25.9	24.9	13.7	4.1	9.6	11.2	4.1
vicinity of Flagler, Kit Carson County							
Mean, 8 ♂	25.10	23.94	13.49	3.91	9.51	10.00	3.68
Minimum	23.9	22.8	13.9	3.8	9.0	8.8	3.6
Maximum	26.2	24.9	14.0	4.0	10.1	10.8	3.8
Mean, 6 ♀	24.68	23.42	13.12	3.90	9.22	9.6	3.67
Minimum	24.0	22.6	12.4	3.7	8.8	9.1	3.5
Maximum	25.5	24.5	13.7	4.1	9.4	10.2	3.9
vicinity of Ramah, El Paso County							
Mean, 7 ♂	24.83	23.66	13.01	3.87	8.97	9.90	3.86
Minimum	24.3	23.0	12.6	3.7	8.7	9.3	3.7
Maximum	25.6	24.4	13.7	4.1	9.4	10.4	4.0
Mean, 10 ♀	25.07	23.93	13.10	3.83	9.02	9.99	3.74
Minimum	24.1	23.1	12.7	3.6	8.8	9.4	3.5
Maximum	25.9	24.8	13.4	4.1	9.5	10.5	4.1
Baca and eastern Las Animas counties							
Mean, 7 ♂	25.14	23.83	13.24	4.14	9.31	9.76	3.91
Minimum	24.2	23.3	12.4	4.0	8.8	9.2	3.7
Maximum	26.0	24.6	14.2	5.6	9.7	10.4	4.3
western Garfield County							
Mean, 8 ♂	25.69	24.51	12.94	4.05	9.26	10.27	3.93
Minimum	24.9	23.7	12.7	3.8	8.9	9.9	3.6
Maximum	26.6	25.5	13.3	4.2	10.2	10.8	4.0
Mean, 6 ♀	25.30	24.51	13.00	4.18	9.07	10.50	3.82
Minimum	24.5	23.4	12.6	3.9	9.6	9.9	3.6
Maximum	26.1	24.7	13.4	4.2	10.3	11.0	4.2

TABLE 19 (Continued)

Selected cranial measurements of three subspecies of *Peromyscus maniculatus.*

Number averaged, sex	Greatest length of skull	Condylo-basal length	Zygomatic breadth	Inter-orbital constriction	Depth of skull	Length of nasals	Length of maxillary toothrow
Peromyscus maniculatus rufinus, Grand Mesa, Mesa and Delta counties							
Mean, 16 ♂	25.74	24.46	13.22	3.99	9.12	10.13	3.91
Minimum	25.0	23.7	12.6	3.8	8.8	9.2	3.6
Maximum	26.9	25.6	14.1	4.2	9.4	11.2	4.3
Mean, 9 ♀	25.39	24.34	13.18	4.01	9.11	10.12	3.83
Minimum	23.5	23.4	12.8	3.8	8.9	9.5	3.6
Maximum	26.2	25.0	13.6	4.4	9.4	10.6	4.1
Gunnison County							
Mean, 7 ♂	25.56	24.31	13.33	4.10	9.24	10.39	3.79
Minimum	25.0	24.0	13.0	4.0	9.0	10.0	3.5
Maximum	26.4	25.0	13.9	4.4	9.5	11.0	4.0
Mean, 8 ♀	26.15	24.98	13.25	4.02	9.31	10.64	3.85
Minimum	25.7	24.5	12.7	3.8	9.0	10.1	3.6
Maximum	26.7	25.8	13.8	4.2	9.6	11.0	4.1
Hinsdale and Mineral counties							
Mean, 8 ♂	25.45	24.01	12.99	3.95	9.17	10.28	3.82
Minimum	24.6	23.1	12.3	3.9	8.8	9.7	3.7
Maximum	26.3	25.1	13.5	4.1	9.5	10.7	4.0
Mean, 6 ♀	25.56	24.07	12.83	3.90	9.14	10.33	3.90
Minimum	24.8	23.3	12.5	3.7	9.0	9.6	3.8
Maximum	26.7	25.4	13.6	4.0	9.3	11.0	4.1
vicinity of Crestone, Saguache County							
Mean, 7 ♂	25.24	23.94	13.06	3.96	9.16	9.83	3.80
Minimum	24.5	23.3	12.8	3.7	8.8	9.3	3.7
Maximum	26.4	25.0	13.5	4.1	9.6	10.2	4.0
Mesa Verde National Park, Montezuma County							
Mean, 12 ♂	25.86	24.53	13.24	4.03	9.32	10.44	3.90
Minimum	25.0	24.1	12.6	3.8	9.0	9.9	3.8
Maximum	27.3	25.8	13.9	4.2	9.8	10.8	4.2
Mean, 16 ♀	25.89	24.60	13.18	4.04	9.32	10.76	3.80
Minimum	25.1	23.7	12.4	3.6	8.9	10.2	3.6
Maximum	26.9	25.7	14.0	4.2	9.6	11.6	4.0

specimens from the extreme eastern part of the state are few, but seem best referred to *nebrascensis,* approaching that subspecies in color as well as in size.

Records of occurrence.—Specimens examined, 160, distributed as follows: YUMA COUNTY: *1 1/2 mi. N, 3 1/2 mi. W Wray,* 8 (KU); Wray, 70 (4 AMNH, 2 CU, 46 DMNH, 1 USNM, 17 WC); *1 mi. S Wray,* 1 (KU); *1 mi. W Laird,* 1 (KU); *1 mi. E Laird,* 1 (KU); Dry Willow, 3 (DMNH); *3 mi. W Hale,* 1 (UI); *2 mi. W Hale,* 1 (KU); *1/2 mi. S, 3 mi. W Hale,* 1 (KU); *1/2 mi. S, 2 mi. W Hale,* 2 (KU); *Bonny Reservoir,* 19 (UI); 1 mi. S, 3 mi. W Hale, 9 (KU); *W end Bonny Reservoir,* 36 (CU). KIT CARSON COUNTY: *4 mi. NE Burlington,* 7 (KU); Burlington, 1 (UMMZ).

Peromyscus maniculatus nebrascensis (Coues)

Hesperomys sonoriensis var. *nebrascensis* Coues, *in* Coues and Allen, Bull. U.S. Geol. Surv. Terr., 11: 79, August 1877; type locality restricted by Jones

(1958b:107) to Deer Creek, approximately 5 mi. from mouth, Converse Co., Wyoming.

Peromyscus maniculatus nebrascensis, Osgood, N. Amer. Fauna, 28:75, 17 April 1909.

Distribution in Colorado.—Plains of eastern part of state; western Colorado at lower elevations in Grand Valley of Colorado River and northward (Fig. 67).

Comparisons.—From *P. m. rufinus*, the subspecies of the mountainous portions of the state, *P. m. nebrascensis* differs in smaller external and cranial size, and generally paler (more grayish and less reddish) dorsal color. For comparison with *P. m. luteus*, see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of 11 males, followed by those of seven females, all from Larimer County at elevations below 6000 feet, are: 152.9 (142-161), 153.2 (148-161); 64.5 (58-78), 64.3 (57-76); 19.8 (18-21), 19.6 (18-21); 17.3 (15-19), 17.6 (17-19). Those of eight males and six females from the vicinity of Flagler are: 155.6 (148-165), 155.0 (149-163); 61.8 (59-65), 64.0 (60-67); 19.8 (18-22), 20.0 (19-20); 16.4 (16-18), 16.5 (16-17); weight, 22.81 (19.7-26.9), 21.04 (19.6-23.9). Measurements of seven males and nine females from the vicinity of Ramah are: 155.1 (149-159), 158.3 (145-174); 65.7 (64-67), 64.6 (56-71); 20.0 (19-21), 19.8 (19-20); 16.3 (15-17), 17.2 (17-18); weight, 21.33 (18.6-25.0), 25.3 (22.1-29.5).

Mean (and extreme) external measurements of six males from extreme southeastern Colorado are: 154.0 (140-159), 63.7 (57-71), 19.8 (18-21), 15.3 (14-17); weight, 21.48 (18.1-25.9). Those of eight males and six females from western Garfield County are: 157.9 (150-167), 160.8 (148-179); 65.8 (60-75), 71.2 (63-82); 19.8 (19-21), 19.5 (19-21); 18.9 (17-21), 19.2 (17-21); weight, 22.79 (20.6-24.6), 24.73 (21.9-27.1). Representative cranial measurements are presented in table 19.

Remarks.—As is generally true through its range *P. maniculatus* is highly variable in Colorado, both within and between populations. Despite the relatively large number of specimens available for study, meaningful samples are lacking for several parts of the state. In addition, a large proportion of the available material consists of immature individuals and is not useful in a preliminary study of geographic variation such as is undertaken here. An intensive statistical study of geographic variation in Coloradan deer mice would be of considerable interest.

Within the range of *P. m. nebrascensis*, considerable local variation is to be observed. Specimens from the Colorado Piedmont and from the Wyoming Basin approach closely topotypical *nebrascensis* from east-central Wyoming. On the High Plains to the east, there is a tendency toward the small size and bright color of *P. m. luteus*. Along the eastern front of the mountains, there is an increase in external size and populations approach *P. m. rufinus*.

In color, there is a rather abrupt break between *nebrascensis* and *rufinus*, generally between 6500 and 7500 feet, and corresponding with the boundary of well-developed montane forest. In canyons, the influence of the plains-adapted race is seen in the pale color of a majority of specimens, whereas darker mice extend to lower elevations on major dividing ridges, along with characteristic montane forest. This pattern deserves detailed study. It is quite apparent in samples from the north-central part of the state, representing canyons such as the Big Thompson and Cache la Poudre. In major openings in the montane forest at moderate elevations, populations typically are highly variable. In Estes Park, for example, individuals referable to both subspecies, as well as apparent intergrades, are to be found.

In general, on the Eastern Slope the boundary between the two subspecies is fairly well defined, and the zone of intergradation is narrow. The relationship between *nebrascensis* and *rufinus* on the Park Plateau and adjacent areas has not been documented, but would be an interesting problem for study.

On the Western Slope, the relationship between *rufinus* and *nebrascensis* is similar. As in the east, the zone of intergradation is narrow. Intergradation is apparent in samples from the western flank of the Elkhead Mountains, northeast of Craig. Similarly, intergradation occurs along the base of the White River Plateau, both northeast and southeast of Meeker, and along the Grand Hogback south of Meeker. On the Roan Plateau, individuals average larger than is usual for *P. m. nebrascensis,* but in color agree well with that subspecies.

Records of occurrence.—Specimens examined, 1074, distributed as follows: MOFFAT COUNTY: Four Mile Creek, 6 mi. SW Baggs, Wyoming, 5 (USNM); [Little] Snake River, 20 mi. W Baggs, 3 (USNM); *Beaver Creek, 7 mi. NE Ladore, 6000 ft.,* 8 (CM); *[Little] Snake River, S of Sunny Peak,* 1 (USNM); Ladore, 2 (USNM); 20 mi. NW Sunbeam, 5 (CM); *Douglas Spring,* 3 (WC); *Escalante Hills, 20 mi. SE Ladore,* 1 (USNM); *[Little] Snake River,* 7 (6 DMNH, 1 WC); Bear [Yampa] River at Sand Creek, 4 (WC); *2 mi. SE Greystone,* 5 (CM); *Two Bar Spring [20 mi. NE junction Little Snake and Yampa rivers],* 16 (DMNH); *[Little] Snake River, lower bridge,* 1 (WC); *Lay Creek, near Lay,* 1(CSU); Lay, 6160 ft., 6 (2 AMNH, 1 CSU, 2 USNM, 1 WC); *Castle Park, Dinosaur National Monument,* 10 (CU); Echo Park, 10 mi. N Artesia [Dinosaur], 2 (KU); *10 mi. W Craig,* 8 (CM); *6 mi. W Craig,* 1 (UMMZ); *5 mi. W Craig,* 1 (CM); Craig, 6100 ft., 5 (1 AMNH, 4 WC); *near Craig, 6100 ft.,* 1 (AMNH); *Yampa River, 1/2 mi. W Colorado Highway 13,* 1 (CSU); *Mantle's Cave, Dinosaur National Monument,* 3 (CU); *Pot Creek, near Pat's Hole,* 4 (DMNH); *Hell's Canyon,* 2 (CU); *N bank Yampa River, 4 mi. NNW Cross Mountain,* 9 (CM); *Lily, 5500 ft.,* 19 (16 CM, 1 DMNH, 2 USNM); *26 mi. N Rangely,* 1 (CM); *S bank Yampa River, 5 mi. NW Cross Mountain,* 17 (16 CM, 1 KU); *1 mi. SE Cross Mountain,* 6 (CM); *2 mi. SE Cross Mountain,* 7 (CM); 1 mi. E Elk Springs, 4 (CM). LARIMER COUNTY: *35 mi. [by road] N Fort Collins,* 1 (CSU); *26 mi. N Fort Collins,* 1 (CSU); 25 mi. N Fort Collins, 1 (CSU); *Table Mountain,* 1 (CSU); *3 mi. N, 1/4 mi. E Livermore,* 1 (CSU); *3 mi. N, 1/2 mi. E Livermore,* 1 (CSU); *1/2 mi. N, 1/4 mi. E Livermore,* 1 (CSU); *15 mi. N Fort Collins,* 2 (CSU); *14 mi. N Fort Collins,* 5 (CSU); *14 8/10 mi. NNE Fort Collins,* 1 (CSU); *10 mi. N, 6 mi. W Fort Collins,* 4 (CSU); *10 mi. N, 5 mi. W Fort Collins,* 1 (CSU); *10 mi. N Fort Collins,* 2 (1 CSC, 1 CSU); *2 mi. NE Wellington,* 2 (DMNH); *1 mi. N, 3 mi. E Wellington,* 1 (CSU); *1/2 mi. N, 2 mi. E Wellington,* 2 (CSU); *9 mi. N, 3 mi. W Fort Collins,* 1 (CSU); *Wellington,* 2 (CSU); *8 mi. N, 2 mi. W Fort Collins,* 1 (CSU); *8 mi. N Fort Collins,* 1 (CSU); *1 mi. S, 4 mi. W Wellington,* 1 (CSU); *4 mi. N Bellvue,* 1 (CSU); *10 mi. NE Fort Collins,* 1 (CSU); *Bennett Creek, 7600 ft.,* 5 (CSU); *8 mi. NW Fort Collins,* 2 (CSU); *3 mi. N, 2 mi. W Laporte,* 2 (CSU); *3 mi. N Laporte,* 2 (CSU); *6 mi. N, 2 mi. W Fort Collins,* 1 (CSU); *6 mi. N Fort Collins,* 2 (CSU); *8 1/2 mi. NE Fort Collins,* 1 (CSU); *5 1/2 mi. N, 1/2 mi. E Fort Collins,* 2 (CSU); *7 1/2 mi. NE Fort Collins,* 2 (CSU); *5 mi. N Fort Collins,* 2 (CSU); *7 mi. NW Fort Collins,* 2 (CSU); *2 mi. NE Laporte,* 1 (CSU); *6 mi. NW Fort Collins,* 2 (CSU); *4 mi. N, 2 mi. E Fort Collins,* 2 (CSU); *Cobb Lake,* 2 (CSU); *5 mi. NW Fort Collins,* 6 (CSU); *Terry Lake,* 1 (CSU); *4 3/4 mi. NW Fort Collins,* 1 (CSU); *3 mi. N, 8 mi. W Fort Collins,* 1 (CSU); *Watson Lake,* 1 (CSU); *3 mi. N, 7 mi. W Fort Collins,* 1 (CSU); *4 1/2 mi. NE Fort Collins,* 7 (CSU); *1 mi. W Laporte,* 1 (CSU); *3 mi. N, 5 mi. W Fort Collins,* 3 (CSU); *3 mi. N, 4 mi. W Fort Collins,* 1 (CSU); *Rist Canyon, 3 mi. W Bellvue,* 3 (UI); *3/4 mi. E Bellvue,* 1 (CSU); *3 mi. N, 2 1/2 mi. W Fort Collins,* 2 (CSU); *3 mi. N Fort Collins,* 3 (CSU); *3 mi. N, 5 mi. E Fort Collins,* 1 (CSU); *4 mi. NW Fort Collins,* 1 (CSU); *4 mi. NE Fort Collins,* 2 (CSU); *sec. 31, T. 8 N, R. 68 W,* 1 (CSU); *Bingham Hill,* 1 (CSU); *2 1/2 mi. N Fort Collins,* 2 (CSU); *2 mi. N, 5 mi. W Fort Collins,* 3 (CSU); *2 mi. N, 4 mi. W Fort Collins,* 3 (KU); *2 mi. N, 2 mi. W Fort Collins,* 1 (CSU); *2 mi. N, 1 mi. E Fort Collins,* 1 (CSU); *2 1/2 mi. NE Fort Collins,* 3 (CSU); *2 mi. NW Fort Collins,* 4 (CSU); *1 1/2 mi. N Fort Collins,* 2 (CSU); *SE 1/4 sec. 6, T. 7 N, R. 69 W,* 1 (CSU); *1 mi. N, 4 mi. W Fort Collins,* 8 (CSU); *1 mi. N, 1 1/2 mi. E Fort Collins,* 1 (CSU); *1 mi. N, 1 3/4 mi. E Fort Collins,* 1 (CSU); *3/4 mi. N, 4 1/2 mi. W Fort Collins,* 1 (CSU); *1/2 mi. N Fort Collins,* 2 (CSU); *2 mi. N Dixon Dam,* 1 (CSU); *6 mi. W Fort Collins,* 8 (CSU); *5 mi. W Fort Collins,* 7 (CSU); *3 mi. S Bellvue,* 1 (CSU); *4 4/10 mi. W Fort Collins,* 3 (CSU); *4 mi. W Fort Collins,* 1 (CSU); *3 1/2 mi. W Fort Collins,* 4 (CSU); *3 mi. W Fort Collins,* 1 (CSU); *2 1/2 mi. W Fort Collins,* 2 (CSU); *2 mi. W Fort Collins,* 2 (CSU); *1 mi. W Fort Collins,* 7 (CSU); Fort Collins, 18 (17 CSU, 1 WC); *1/8 mi. E Fort Collins,* 2 (CSU); *1/4 mi. E Fort Collins,* 2 (CSU); *1/2 mi. E Fort Collins,* 4 (CSU); *1 mi. E Fort Collins,* 1 (CSU); *1 9/10 mi. E Fort Collins,* 1 (CSU); *6 mi. E Fort Collins,* 1 (CSU); *1/2 mi. S, 1 1/4 mi. E Fort Collins,* 1 (CSU); *1 mi. SW Fort Collins,* 1 (CSU); *1 mi. S, 4 mi. W Fort Collins,* 14 (CSU); *1 mi. S, 3 1/2 mi. W Fort Collins,* 1 (CSU); *1 mi. S, 3 mi. W Fort Collins,* 2 (CSU); *1 mi. S, 2 mi. W Fort Collins,* 4 (CSU); *1 mi. S, 1 mi. W Fort Collins,* 2 (CSU); *1 mi. S Fort Collins,* 3 (CSU); *1 1/2 mi. SW Fort Collins,* 1 (CSU); *3 mi. ESE Fort Collins,* 3 (CSU); *1/4 mi. N Dixon Dam,* 1 (CSU); *1 1/2 mi. S, 4 mi. W Fort Collins,* 3 (CSU); *Dixon Dam,* 9 (CSU); *Dixon Lake,* 5 (CSU); *2 8/10 mi. SW Fort Collins,* 3 (CSU); *2 mi. S, 4 mi. W Fort Collins,* 2 (CSU); *2 mi. S, 3 mi. W Fort Collins,* 1 (CSU); *2 mi. S, 2 mi. E Fort Collins,* 1 (CSU); *1 mi. SE Dixon Dam,* 1 (CSU); *1 mi. S Dixon Dam,* 1 (CSU); *2 1/2 mi. S, 3 1/2 mi. W Fort Collins,* 1 (CSU); *2 1/2 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *3 3/4 mi. SW Fort Collins,* 1 (CSU); *SW 1/4 sec. 27, T. 7 N, R. 68 W,* 2 (CSU); *4 mi. SW Fort Collins,* 7 (CSU); *Horsetooth Reservoir,* 2 (CSU); *3 mi. S, 2 mi. W Fort Collins, 5200 ft.,* 4 (CSU); *3 mi. S, 1 1/2 mi. W Fort Collins,* 1 (CSU); *3 mi. S Fort Collins,* 1 (CSU); *3 mi. S, 1 mi. E Fort Collins,* 3 (CSU); *3 mi. S, 2 mi. E Fort Collins,* 1 (CSU); *4 1/4 mi. SE Fort Collins,* 2 (CSU); *1 mi. N Timnath,* 1 (CSU); *4 1/2 mi. SW Fort Collins,* 12 (CSU); *4 1/2 mi. SE Fort Collins,* 1 (CSU); *1/2 mi. N Spring Canyon Dam,* 3 (CSU); *3 4/10 mi. S Fort Collins,* 2 (CSU); *1/2 mi.*

NE Spring Canyon Dam, 1 (CSU); *5 mi. SW Fort Collins,* 16 (1 CSC, 15 CSU); *5 mi. SE Fort Collins,* 2 (CSU); *Spring Canyon,* 3 (2 CSU, 1 CU); *Spring Canyon Dam,* 16 (CSU); *5 1/5 mi. SW Fort Collins,* 2 (CSU); *5 1/2 mi. SW Fort Collins,* 5 (CSU); *1/4 mi. SE Spring Canyon Dam,* 1 (CSU); *1/4 mi. S Spring Canyon Dam, 5000 ft.,* 1 (CSU); *4 mi. S, 6 mi. W Fort Collins,* 1 (CSU); *4 mi. S, 2 mi. W Fort Collins,* 2 (CSU); *4 mi. S, 1/4 mi. W Fort Collins,* 2 (CSU); *4 mi. S Fort Collins,* 2 (CSU); *6 mi. SW Fort Collins,* 4 (CSU); *1/2 mi. S, 1/5 mi. E Spring Canyon Dam,* 2 (CSU); *2/10 mi. S Horsetooth Reservoir, 5200 ft.,* 2 (CSU); *4 4/10 mi. S, 3 8/10 mi. E Fort Collins,* 1 (CSU); *1/2 mi. S Horsetooth Reservoir,* 1 (CSU); *4 1/2 mi. S Fort Collins,* 1 (CSU); *6 1/2 mi. SW Fort Collins,* 1 (CSU); *sec. 4, T. 6 N, R. 68 W,* 1 (CSU); *6 7/10 mi. SW Fort Collins,* 1 (CSU); *5 mi. S, 2 mi. W Fort Collins,* 2 (CSU); *5 mi. S, 1/2 mi. W Fort Collins,* 1 (CSU); *5 mi. S Fort Collins,* 4 (CSU); *5 mi. S, 1 1/2 mi. E Fort Collins,* 1 (CSU); *5 mi. S, 1 3/4 mi. E Fort Collins,* 6 (CSU); *7 mi. SE Fort Collins,* 6 (CSU); *sec. 10, T. 6 N, R. 69 W,* 1 (CSU); *5 6/10 mi. S, 2 4/10 mi. E Fort Collins,* 1 (CSU); *6 mi. S, 1 mi. W Fort Collins,* 4 (CSU); 9 mi. SW Fort Collins, 1 (CSU); *Fossil Creek Reservoir,* 4 (CSU); *4 1/2 mi. W Windsor,* 1 (CSU); *9 1/2 mi. SE Fort Collins,* 1 (CSU); *1/2 mi. E Masonville,* 2 (CSU); *SW 1/4 sec. 15, T. 6 N, R. 69 W,* 1 (CSU); *7 mi. S, 1 mi. W Fort Collins,* 1 (CSU); *7 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *8 mi. S, 2 1/2 mi. W Fort Collins,* 1 (CSU); *14 mi. [by road?] SW Fort Collins, 5400 ft.,* 1 (CSU); *9 1/2 mi. SSW Fort Collins,* 1 (CSU); *2 mi. N, 1 mi. W Loveland,* 1 (CSU); *2 mi. N Loveland,* 2 (CSU); *2 1/2 mi. WNW Loveland,* 3 (CSU); 4 mi. W Loveland, 1 (CU); *3 1/2 mi. W Loveland, 5030 ft.,* 6 (3 CSU, 3 KU); *Loveland,* 32 (USNM). WELD COUNTY: *1/2 mi. NW Carr,* 1 (CSU); *16 mi. W Grover,* 6 (DMNH); *Grover,* 7 (DMNH); Pawnee Buttes, 5300 ft., 4 (2 USNM, 2 WC); 10 mi. NE Nunn, 2 (USNM); *Horsetail Creek, 17 mi. NW Stoneham,* 9 (DMNH); 1 mi. N, 6 mi. W Nunn, 1 (CSU); *Central Plains Experiment Station, near Nunn,* 15 (UNM); *12 mi. NW New Raymer,* 34 (CU); 8 mi. N New Raymer, 3 (CU); *3 mi. W Briggsdale,* 4 (CSU); *1/4 mi. NE Black Hollow Reservoir,* 1 (CSU); *3 mi. N, 19 mi. E Fort Collins,* 1 (CSU); *2 1/2 mi. N, 12 1/2 mi. E Fort Collins,* 1 (CSU); 1 mi. N, 19 mi. E Fort Collins, 1 (CSU); *10 mi. E Fort Collins,* 1 (CSU); *12 mi. E Fort Collins,* 2 (CSU); *13 mi. E Fort Collins,* 2 (CSU); *1/2 mi. S, 1/2 mi. E junction Colorado highways 14 and 257,* 1 (CSU); *1/2 mi. E Windsor,* 1 (CSU); *3 mi. SE Windsor,* 1 (CSU); 2 mi. S Windsor, 1 (CSU); 5 mi. W Kersey, 1 (CSU); N of La Salle, 1 (CSC); *3 mi. W La Salle,* 1 (CSC); *2 mi. W La Salle,* 2 (CSC); 6 mi. E Platteville, 2 (CSU); 4 mi. NE Hudson, 2 (CSU). MORGAN COUNTY: Orchard, 1 (UMMZ). LOGAN COUNTY: Chimney Canyon, 10 mi. NE Avalo, 6 (USNM); *10 mi. E Avalo,* 1 (USNM); *21 mi. N, 5 mi. E Stoneham, 4700 ft.,* 1 (KU); *1 1/2 mi. S, 12 mi. W Peetz,* 5 (KU); 2 1/2 mi. S, 12 mi. W Peetz, 4 (KU); 7 mi. E Crook, 2 (WSC). SEDGWICK COUNTY: 3 1/2 mi. NW Sedgwick, 1 (CU); 5 mi. SW Julesburg, 1 (DMNH). RIO BLANCO COUNTY: *6 mi. N Rangely,* 4 (CM); White River, 20 mi. E Rangely, 1 (USNM); 5 mi. N, 10 mi. W Rangely, 1 (KU); *N side White River, 1 mi. N Rangely, 5200 ft.,* 8 (CM); *5 mi. W Rangely, 5600 ft.,* 2 (USNM); *N side White River, 1 mi. W Rangely,* 2 (CM); *1 1/2 mi. S, 6 mi. W Rangely,* 1 (KU); *N side White River, 4 mi. W Meeker,* 7 (CM); Meeker, 6200 ft., 12 (3 DMNH, 7 USNM, 2 WC); 18 mi. S, 2 mi. E Rangely, 2 (KU); *Douglas Creek, 19 mi. S Rangely,* 4 (CM); East Fork Douglas Creek at Cathedral Creek, 3 (DMNH). GARFIELD COUNTY: head of Douglas Creek, 7700 ft., 4 (CM); *Atchee, 6600 ft.,* 2 (WC); Baxter Pass, 8500 ft., 3 (USNM); *West Fork Douglas Creek, 35 mi. S Rangely, 8000 ft.,* 46 (CM); *29 mi. N, 5 mi. W Mack, 7250 ft.,* 1 (KU); *28 mi. N, 5 mi. W Mack, 7250 ft.,* 16 (KU); 20 mi. N Mack, 4 (CM). BOULDER COUNTY: *Lyons,* 9 (FMNH); 3 1/2 mi. SW Lyons, 2 (CU); *8 1/2 mi. N, 3 1/4 mi. W Boulder,* 3 (CU); *5 mi. N Valmont,* 1 (CU); *3 1/2 mi. ENE Valmont, 5150 ft.,* 6 (CU); Valmont, 2 (1 CU, 1 USNM); *1 mi. E Valmont,* 1 (CU); *Valmont Butte,* 1 (CU); 5 mi. W Boulder, 5600 ft., 6 (USNM); *3 1/10 mi. W Boulder,* 1 (CU); *Boulder Canyon, 2 mi. W Boulder,* 2 (KU); *Boulder,* 18 (7 ANSP, 6 CU, 5 USNM); *1 mi. E Boulder,* 2 (CU); *2 mi. E Boulder,* 2 (CU); *3 mi. E Boulder,* 1 (CU); *mouth of Boulder Canyon,* 3 (CU); *Boulder Canyon,* 3 (CU); *base of Flagstaff Mountain,* 1 (CU); *Flagstaff Mountain,* 2 (CU); *Gregory Canyon,* 12 (CU); *Long Canyon, NW slope of Green Mountain,* 5 (CU); *Mount Sanitas,* 17 (CU); *Skunk Canyon, S of Boulder,* 9 (CU); *Horse Mesa,* 2 (CU); *5 mi. S Boulder,* 5 (CU); *Superior,* 1 (FWS); 1 mi. E Gross Dam, 2 (CU); *6 mi. S, 1 1/2 mi. E Boulder,* 6 (CU); *Coal Creek, on Marshall-Golden Road,* 1 (CU); *8 mi. W Broomfield,* 1 (CU). JEFFERSON COUNTY: *1 1/4 mi. W Semper,* 16 (DMNH); *Semper,* 18 (3 CSU, 5 DMNH, 10 KU); *Arvada,* 4 (CU); *Eleanor,* 1 (DMNH); Golden, 8 (5 DMNH, 3 CU); *3 mi. E Golden, 5480 ft.,* 1 (CSU); *hogback W of Federal Center,* 2 (FWS); *Green Mountain,* 2 (CSU); *Morrison,* 1 (SC); *no locality other than county,* 1 (FWS). ADAMS COUNTY: *Barr,* 4 (DMNH); 10 mi. N Denver, 1 (CU); *Croak's [Croke] Lake, 7 mi. N Denver,* 24 (DMNH); *Mile Hi Gun Club,* 6 (DMNH); *Globe Smelter,* 1 (DMNH); *Clear Creek at Washington Street,* 4 (DMNH); *South Platte River at Sand Creek,* 1 (DMNH); 3 mi. S, 1 mi. W Simpson, 8 (KU). DENVER COUNTY: Denver, 22 (1 AMNH, 7 DMNH, 2 FWS, 12 USNM). ARAPAHOE COUNTY: 10 mi. E Denver, 1 (DMNH); *Sullivan Dam,* 3 (DMNH); *2 mi. S, 10 1/2 mi. W Aurora,* 1 (CSU); *Littleton,* 1 (WC); *2 7/10 mi. SE Denver,* 8 (CU); 6 mi. E Cherry Creek Reservoir, 1 (DMNH). WASHINGTON COUNTY: Cope, 22 (KU). MESA COUNTY: Stateline, 4 (CM); Fruita, 1 (USNM); *1 mi. SW Fruita,* 3 (DMNH); *2 mi. W Grand Junction,* 3 (DMNH); Grand Junction, 3 (DMNH); *near Grand Junction,* 2 (FMNH); *Warehouse, Colorado National Monument,* 2 (1 CNM, 1 CU); *rim above Coke Ovens, Colorado National Monument,* 2 (CU); *Colorado National Monument,* 33 (1 CNM, 32 CU); Sieber Ranch, Little Dolores Creek, 1 (WC). DOUGLAS COUNTY: *D'Arcy Ranch, 2 mi. N Parker,* 4 (DMNH); Parker, 5 (DMNH); *3 mi. SE Parker,* 5 (DMNH); *7 mi. N, 4 mi. W Castle Rock,* 1 (KU); Daniel's Park, 1 (DMNH); 10 mi. SW Castle Rock, 1 (UMMZ). ELBERT COUNTY: 8 mi. NE Agate, 5 (DMNH); *8 mi. N Riverbend,* 3 (CU); 6 mi. N Riverbend, 7 (CU); Elbert, 2 (WC); 7 mi. N Ramah, 1 (UMMZ). LINCOLN COUNTY: Limon, 1 (UMMZ); 1/4 mi. S, 6 mi. E Rush, 2 (FHSC). KIT CARSON COUNTY: Tuttle, 1 (USNM); *Flagler,* 1 (USNM); *4 mi. E Flagler,* 4 (KU); 4 1/2 mi. E Flagler, 6 (KU). EL PASO COUNTY: 2 mi. W Ramah, 5900 ft., 17 (KU); Eastonville, 3 (1 MCZ, 2 WC); 6 mi. S Ramah, 1 (UMMZ); 6 mi. E Peyton, 1 (KU); 6 mi. N, 1 mi. W Colorado Springs, 8 (UI); *3 mi. N Colorado Springs,* 13 (3 AMNH, 10 WC); *Minnehaha,* 2 (UMMZ); *Manitou,* 2 (UMMZ); *3 mi. NE Colorado Springs, 6000 ft.,* 1 (WC); *Hunters Creek, near Bear Creek,* 3 (WC); *W of Colorado Springs,* 15 (2 AMNH, 1 UMMZ, 1 USNM, 11 WC); *Colorado Springs,* 35 (3 AMNH, 1 CSU, 1 MCZ, 30 WC); *3/4 mi. below mouth Bear Creek Canyon,* 2 (WC); *1/2 mi. S Bear Creek, near Colorado Springs,* 3 (1 AMNH, 2 WC); *2 mi. E Colorado Springs,* 3 (WC); 10 mi. S Colorado Springs, 2 (KU); *Van Andert's Spring, Little Fountain Creek, 6200 ft.,* 1 (WC); 20 mi. S Colorado Springs, 2 (CM). CHEYENNE COUNTY: 10 mi. S Firstview, 12 (CU). FREMONT COUNTY: 4 1/2 mi. NE Penrose, 2 (UI); Cañon City, 1 (USNM). PUEBLO COUNTY: Turkey Creek, E of Stone City, 17 (CU); *T. 20 S, R. 65 W, 4500 ft.,* 1 (SCSC); *1 mi. N Pueblo,* 1 (SCSC); *Overton Road at Fountain Creek,* 1 (SCSC); *1 mi. N, 8 mi. E Pueblo, 4700 ft.,* 1 (SCSC); 5 mi. W Pueblo, 1 (SCSC); *2 mi. E Pueblo,* 1 (SCSC); *8 mi. E Pueblo,* 1 (SCSC); *St. Charles River,* 1 (USNM); *near Stem Beach,* 1 (SCSC); 25 mi. SE Pueblo, 2 (CU). CROWLEY COUNTY: Sugar City, 1 (FWS); 1 mi. N Fowler, 1 (CSU). HUERFANO COUNTY: 20 mi. E Walsenburg, 3 (DMNH). BENT COUNTY: 2 mi. S, 2 mi. E Hasty, 6 (KU); SE corner Bent County, 2 (CU). PROWERS COUNTY: *Lamar,* 3 (KU); 1 mi. S Lamar, 1 (KU); Two Buttes Peak, 4500 ft., 4 (KU); *[near] Two Buttes Reservoir,* 1 (UI). LAS ANIMAS COUNTY: junction Plum and Chacuacho creeks, 2 (CU); *3 1/2 mi. S, 5 mi. W Kim,* 9 (KU); 7 1/2 mi. S, 4 mi. W Kim, 2 (KU); Trinchera, 15 (DMNH); *Watervale,* 1 (CU); 3 mi. W Branson, 4 (KU); *Cook Ranch, Hillside Spring* (not found), 1 (CSU). BACA COUNTY: *15 mi. N, 4 mi. E Springfield,* 1 (KU); *14 mi. N, 4 mi. E Springfield,* 4 (KU); Gaume's Ranch, 7 (WC); Two Buttes, 41 (DMNH); *William's Corner, 9 mi. N Springfield,* 22 (DMNH); *Springfield,* 1 (CSU); Furnace [Furnish] Canyon, 2 (DMNH); Regnier, 3 (DMNH); Craugh Ranch, Cimarron River, 2 (DMNH).

Additional records: WELD COUNTY: *1 mi. S, 6 mi. W Platteville* (Archibold, 1964:44). MESA COUNTY: *Colorado National Monument* (for details of local distribution, see P. H. Miller, 1964:65-66). EL PASO COUNTY: 14 mi. E Fountain (Norris and Banta, 1965:54).

Peromyscus maniculatus rufinus (Merriam)

Hesperomys leucopus rufinus Merriam, N. Amer. Fauna, 3:65, 11 September 1890; type locality, San Francisco Mountain, 9000 ft., Coconino Co., Arizona.

Peromyscus maniculatus rufinus, Osgood, N. Amer. Fauna, 28:72, 17 April 1909.

Distribution in Colorado.—Mountains of central and western parts of state, and southwestern Colorado, south of Grand Valley of the Colorado River (Fig. 67).

Comparison.—For comparison with *P. m. nebrascensis,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of 16 males, followed by those of nine females, all from the Grand Mesa, are: 162.8 (149-172), 167.7 (156-180); 68.4 (64-72), 70.4 (65-78); 20.4 (18-22), 20.0 (18-21); 18.9 (18-21), 19.2 (17-21); weight, 23.83 (19.4-28.5), 25.37 (20.4-27.0). Those of seven males and eight females from Gunnison County are: 164.8 (153-180), 169.4 (156-180); 70.0 (66-76), 68.2 (60-76); 20.4 (20-21), 20.2 (19-21); 17.1 (15-18), 18.1 (16-20).

Mean (and extreme) external measurements of eight males and six females from Hinsdale and Mineral counties are: 157.0 (145-167), 165.6 (152-176); 69.3 (65-77), 71.7 (62-78); 20.5 (19-21), 20.3 (19-22); 18.5 (18-19), 19.2 (18-20). Those of seven males from near Crestone, Saguache County, are: 157.6 (153-165), 68.3 (62-72), 20.4 (20-21), 18.1 (17-19); weight, 22.73 (19.5-23.9). Those of 12 males and 16 females, all from Mesa Verde National Park, are: 159.1 (150-167), 167.4 (148-177); 69.3 (57-76), 73.3 (59-80); 20.3 (20-22), 20.3 (19-21); 19.6 (18-22), 20.3 (17-23). For cranial measurements, see table 19.

Remarks.—The distribution of *P. m. rufinus,* as currently understood, is polytopic. The range of the subspecies in Colorado is separated from the population of the higher mountains of central and northern Utah by the ranges of *P. m. nebrascensis* and *P. m. sonoriensis,* races characteristic of the northern Great Plains and the Great Basin, respectively. To the south, the range of *rufinus* is continuous into New Mexico and Arizona.

Among specimens examined from Colorado, some from the southwest, in Montezuma and Dolores counties, approach the bright reddish to orangish color of topotypes from the San Francisco Mountains, Arizona. Elsewhere in the state, dorsal color is highly variable, but seldom approaches either the rich tones of mice from the southwest, or the dull grayish brown of *nebrascensis.* However, mice from the San Luis Valley are exceptionally pale for representatives of *rufinus,* not infrequently approaching the color of *nebrascensis.*

Long (1965:631) referred deer mice from the Sierre Madre (in Colorado called the Park Range) and the Medicine Bow Mountains of Wyoming to *P. m. nebrascensis.* Excellent series of specimens are available from northeast of Savery in the Sierra Madre and from the Medicine Bow Range near Encampment. This material is indistinguishable from specimens from north-central Colorado herein referred to *P. m. rufinus.* In open areas at lower elevations in southeastern Wyoming, deer mice occur that clearly are referable to *nebrascensis* as understood by me. In particular, this is true of mice from the Laramie Basin. I have seen no specimens from the Laramie River Valley in western Larimer County, Colorado, but on the basis of ecological and geographic considerations, one would expect *P. m. nebrascensis* to occur there.

Intergradation of *P. m. rufinus* with *P. m. nebrascensis* is apparent in a zone, usually of restricted width, wherever the ranges of the two subspecies meet. Details on intergradation are presented in the account of *P. m. nebrascensis.*

Records of occurrence.—Specimens examined, 2480, distributed as follows: MOFFAT COUNTY: 8 mi. NE Craig, 13 (CM); *8 mi. ENE Craig,* 1 (CM); 9 mi. S Craig, 10 (CM). ROUTT COUNTY: Elkhead Mountains, 20 mi. SE Slater, 1 (USNM); *Hahn's Peak,* 2 (USNM); mouth of Sand Creek, 1 (USNM); *Elk River, 5 mi. N Steamboat Springs,* 1 (DMNH); 7 mi. W Hayden, 1 (CSU); Steamboat Springs, 6750 ft., 4 (1 AMNH, 1 DMNH, 1 USNM, 1 WC); *Rabbit Ears Pass, 9680 ft.,* 3 (CM); Yampa, 2 (WC); Toponas, 1 (DMNH); *Egeria Park, near Toponas,* 2 (USNM); *no locality other than county,* 6 (MCZ). JACKSON COUNTY: Pearl, 9000 ft., 3 (USNM); *near Pearl,* 2 (1 CSU, 1 CU); Mount Zirkel, 11,175 ft., 1 (WC); *Ute Pass, near Mount Zirkel,* 1 (WC); *Boettcher Ranch, near Lake John,* 2 (DMNH); *Lake John,* 2 (WC); Michigan Creek, near Walden, 1 (CSU); Canadian Creek, 7 (USNM); *5 mi. S Walden,* 1 (CU); 2 mi. N, 2 mi. E Gould, 8600 ft., 12 (KU); S of Rabbit Ears Peak, 1 (CU); Arapaho Pass, 1 (USNM). LARIMER COUNTY: *46 mi. [by road] NW Fort Collins,* 1 (CSU); *1 mi. E West Lake, 8300 ft.,* 1 (CSU); 1 mi. S, 20 mi. W Livermore, 8400 ft., 1 (KU); *1 mi. N Owl Canyon,* 3 (CSU); Owl Canyon, 14, (1 ASC, 1 CSU, 12 UI); 4 mi. S, 14 mi. W Livermore, 7500 ft., 2 (KU); *18 mi. NW Fort Collins,* 2 (CSU); *14 mi. NW Fort Collins,* 4 (USNM); Home P. O., 1 (CSU); *Rustic,* 1 (CSU); *12 mi. NW Fort Collins,* 1 (CSU); *8 mi. N, 15 mi. W Fort Collins,* 1 (UI); *"Pudder" [Poudre?] Canyon,* 1 (DMNH); *sec. 2, T. 8 N, R. 71 W,* 1 (CSU); *1 mi. S, 11 mi. W Rustic,* 5 (KU); *Fort Collins Recreation Area,* 3 (FMNH); *10 mi. NW Fort Collins,* 4 (CSU); *Bennett Creek, 7600 ft.,* 5 (CSU); *1 1/2 mi. S, 12 1/2 mi. W Rustic,* 2 (KU); *5 mi. N, 13 mi. W Fort Collins,* 2 (CSU); *1 1/2 mi. N, 3 mi. W Buckhorn Ranger Station,* 2 (CSU); 5 mi. W Laporte, 3 (CSU); Chambers Lake, 3 (2 CSU, 1 WC); *NW 1/4 sec. 17, T. 7 N, R. 72 W, 8680 ft.,* 1 (CSU); *3 mi. below Cameron Pass,* 1 (WC); *South Fork, Cache la Poudre River, T. 7 N, R. 73 W,* 9 (UNM); *Fall Creek Bridge, Pingree Park,* 1 (CSU); *4 mi. S, 11 mi. W Fort Collins,* 3 (CSU); *12 mi. SW Fort Collins,* 1 (CSU); *North Fork Campground, E of Glen Haven,* 1 (CU); *2 mi. SW Masonville,* 1 (CSU); *3 mi. E Glenhaven,* 1 (CU); *Devil's Gulch,* 1 (CSU); *15 mi. SW Fort Collins,* 2 (CSU); *Rocky Mountain National Park, 10,000 ft.,* 1 (UI); *Fall Creek, 9700 ft.,* 1 (USNM); *3 mi. N, 3 mi. E Estes Park,* 3 (FHSC); *1/4 mi. E Rock Cut, Trail Ridge Road,* 3 (RMNP); *2 1/2 mi. N, 4 mi. W Estes Park,* 2 (FHSC); *9 mi. WNW Estes Park, 9000 ft.,* 6 (FHSC); *1/4 mi. above Hidden Valley Lodge,* 3 (RMNP); *8 mi. WNW Estes Park,* 2 (FHSC); *Lower Hidden Valley,* 3 (RMNP); *Upper Hidden Valley, 10,500 ft.,* 12 (RMNP); *1/2 mi. below Upper Hidden Valley,* 2 (RMNP); *1/4 mi. below Upper Hidden Valley,* 2 (RMNP); *Aspenglen Campground,* 5 (4 CU, 1 RMNP); *1 mi. W Deer Ridge Junction,* 5 (RMNP); Estes Park, 7600 ft., 71 (2 AMNH, 1 CSC, 2 KU, 1 RMNP, 64 USNM, 1 WC); *Moraine Park,* 13 (RMNP); *near Buck Creek, SE of utility area,* 1 (RMNP); *Buck Creek,* 3 (RMNP); *2 mi. S, 2 mi. W Estes Park,* 1 (KU); *3 1/2 mi. SW Estes Park,* 1 (KU); *3 mi. S, 3 mi. W Estes Park,* 2 (KU); *Hallowell Park, 4 mi. SW Estes Park,* 14 (RMNP); *3 mi. S, 11 mi. W Estes Park, 12,000 ft.,* 6 (UI); *Mill Creek,* 2 (RMNP); *4 1/2 mi. SW Estes Park,* 30 (KU); *4 mi. S Estes Park,* 8 (KU); *Bear Lake, 9485 ft.,* 2 (DMNH); *8 mi. N Allenspark,* 1 (CU); *Longs Peak,* 38 (USNM). RIO BLANCO COUNTY: *8 mi. NE Meeker,* 2 (CM); *7 mi. NE Meeker,* 3 (CM); 9 1/2 mi. SW Pagoda Peak, 7700 ft., 8 (KU); *6 mi. NE Meeker,* 7 (CM); *Lost Creek, 9 mi. NE Buford,* 11 (CM); *Big Beaver Creek, 6800 ft.,* 1 (AMNH); *Little Beaver [Creek?], Routt*

[White River] National Forest, 1 (DMNH); *Big Beaver Ranch, near Buford, 6700 ft.,* 2 (WC); *Marvine,* 3 (USNM); *Marvine Lodge,* 2 (CU); *Grand Hogback, 5 mi. S Meeker,* 14 (CM); *Buford,* 4 (WC); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 25 (CM); *15 mi. SE Meeker,* 4 (CM); *White River Plateau,* 3 (USNM); *8 mi. SE South Fork Campground, White River National Forest,* 2 (CSU). GARFIELD COUNTY: *Stillwater Reservoir, 10,300 ft.,* 7 (DMNH); *Middle Stillwater Creek, near Dome Peak,* 1 (DMNH); 1 mi. NW Trappers Lake, 7 (CM); Deep Lake, 16 mi. N Glenwood Springs, 6 (KU); Mud Springs, 8850 ft., 2 (WC); Big Pine Campground, Rifle Mountain Park, 2 (CU); 12 mi. above Glenwood Springs, 3 (1 AMNH, 2 WC); 8 mi. W Rifle, 13 (12 KU, 1 USNM); *7 mi. W Rifle, 5300 ft.,* 2 (USNM); Rifle, 1 (USNM); *Middle Mamm Creek, near Rifle,* 5 (DMNH). EAGLE COUNTY: McCoy, 1 (USNM); *Yarmany Creek, near McCoy,* 2 (WC); *20 mi. SW Toponas,* 1 (DMNH); *Allenton,* 1 (WC); 1 1/2 mi. E Vail, 8450 ft., 2 (CSU). GRAND COUNTY: *1/4 mi. W Milner Pass,* 1 (CSU); Kawuneeche Residence Area, Rocky Mountain National Park, 5 (RMNP); Mount Whitely, 1 (USNM); *Grand Lake,* 1 (WC); 3 mi. S, 2 mi. W Grand Lake, 8375 ft., 9 (UNM); 9 1/2 mi. N Kremmling, 1 (WC); *7 mi. S, 3 mi. W Grand Lake, 8360 ft.,* 4 (UNM); Hot Sulphur Springs, 7 (3 AMNH, 4 WC); Kremmling, 7322 ft., 2 (WC); Coulter, 5 (USNM); near Sheephorn Pass, 2 (WC); Berthoud Pass, 1 (FWS). SUMMIT COUNTY: Dillon, 8500 ft., 1 (UI); *1 mi. SE Frisco, 9100 ft.,* 2 (UI); *1 1/2 mi. SE Frisco, 9500 ft.,* 1 (UI); Montezuma, 1 (DMNH); Boreas Pass, 11,500 ft., 1 (WC); *no locality other than county,* 1 (CSU). BOULDER COUNTY: *3/4 mi. N, 2 mi. W Allenspark, 8400 ft.,* 13 (KU); 12 1/2 mi. S Estes Park, 8400 ft., 1 (KU); Buchanan Pass, 10,800 ft., 1 (USNM); *Lefthand Creek,* 1 (CU); *near Ward,* 4 (CU); *Lefthand Creek, SW of Ward,* 1 (CU); *1 mi. SW Ward,* 1 (FHSC); *above Ward, 10,250 ft.,* 1 (CU); *10 mi. NW Nederland, 10,000 ft.,* 1 (CU); *2 mi. W Gold Hill, 9000 ft.,* 3 (KU); Gold Hill, 16 (USNM); *2 mi. SSW Ward, 9250 ft.,* 5 (CU); *3 mi. SSW Ward,* 2 (CU); *3 mi. S Ward, 9000 ft.,* 1 (KU); *3 mi. S, 1/2 mi. W Ward, 9400 ft.,* 1 (KU); *Niwot Ridge, 7 mi. N Nederland,* 6 (2 CU, 3 FMNH, 1 UI); *below Niwot Ridge,* 2 FMNH); *7 mi. NW Nederland,* 1 (UMMZ); *3 mi. SW Niwot Ridge, 10,750 ft.,* 2 (CU); *1/4 mi. N, 1/4 mi. E Science Lodge,* 1 (UI); *Science Lodge,* 4 (CU); *1/2 mi. N Boulder,* 1 (CU); Mount Arapahoe, 1 (ANSP); *1 mi. S Glacier Lake, 8200 ft.,* 1 (UI); Nederland, 7500 ft., 13 (10 FMNH, 3 USNM); Eldora, 2 (CU); *Dixie Lake,* 4 (DMNH); 3 mi. E Pinecliff, 5 (DMNH); *no locality other than county,* 28 (2 DMNH, 26 USNM). GILPIN COUNTY: *Kelly Dahl Campground, Roosevelt National Forest,* 1 (CU); *Tolland,* 9 (CU); *Lump Gulch, S of Rollinsville,* 1 (CU); *Lump Gulch, near Gilpin,* 7 (CU); *end Moon Gulch Road,* 2 (CU); *Dory Hill Pond, near Blackhawk,* 1 (ANSP); Blackhawk, 1 (USNM). CLEAR CREEK COUNTY: Idaho Springs, 5 (KU); *2 mi. S Idaho Springs,* 5 (KU); *Graymount,* 3 (SC); *Silverplume, 10,000 ft.,* 4 (SC); *Mount McClellan,* 1 (USNM); Loveland Pass, 1 (FWS); *Torrey's Peak,* 5 (DMNH); near timberline, Mount Evans, 16 (CU); *Mount Evans,* 1 (CU). JEFFERSON COUNTY: [near] Golden, 7300 ft., 4 (USNM); Lookout Mountain, 3 mi. SW Golden, 2 (1 FWS, 1 WC); 1 mi. S, 6 mi. W Evergreen, 1 (CSU); Geneva Park, 3 (DMNH); Dawson Station, 1 (CSU). MESA COUNTY: De Beque, 1 (USNM); *4 mi. S, 3 mi. E Collbran, 6800 ft.,* 11 (KU); *9 mi. S, 3 mi. E Collbran, 10,200 ft.,* 3 (KU); 8 mi. E Palisade, 1 (CSU); *7 mi. S Glade Park,* 3 (CU); 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft., 1 (KU); *9 mi. S Glade Park,* 10 (CM); Uncompahgre Plateau, 5 mi. S Unaweep Canyon, 8400 ft., 3 (USNM). PITKIN COUNTY: 3 mi. W Redstone, 1 (DMNH); 8 mi. SW Aspen, 1 (CU); Independence Pass, 12,200 ft., 3 (FMNH). LAKE COUNTY: 8 mi. SE Leadville, 10,000 ft., 11 (KU); *12 mi. S, 1 mi. W Leadville,* 1 (KU); Twin Lakes, 1 (USNM); *3 mi. S Twin Lakes,* 4 (KU). PARK COUNTY: *8 mi. NNW Grant, 10,000 ft.,* 2 (KU); Bailey, 4 (SC); *2 1/2 mi. S Estabrook,* 5 (FHSC); Gold-Williams Ranch, Jefferson, 4 (DMNH); Alma, 2 (1 CSU, 1 DMNH); *Sacramento Creek,* 1 (DMNH); *2 1/2 mi. W Fairplay, 10,200 ft.,* 2 (UI); Garo, 9500 ft., 1 (USNM); Williams Ranch, near Tarryall, 13 (DMNH); *Tarryall Creek, 6 mi. above Puma City, 8700 ft.,* 2 (WC); Wilkerson Pass, 9200 ft., 6 (UI); 5 mi. SE Guffey, 2 (CU); *South Park,* 2 (DMNH); *Levic* (not found), 1 (DMNH). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 10,200 ft., 3 (KU); *1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 5 (KU); *1 mi. S, 8 mi. E Skyway, 10,000 ft.,* 5 (KU); *2 mi. S, 8 mi. E Skyway, 9000 ft.,* 5 (KU); *2 1/2 mi. S, 8 mi. E Skyway, 9600 ft.,* 4 (KU); *Trickle Park Campground, 37 mi. E Grand Junction,* 1 (UI); *[near] Cedaredge, 10,200 ft.,* 1 (FMNH); Eckert [Orchard City], 1 (SC); *Gunnison River, 24 mi. S[E] Grand Junction,* 4 (CU); Hotchkiss, 1 (FMNH); 3 mi. E Delta, 4900 ft., 1 (CSU); *near Crawford,* 1 (CSU). GUNNISON COUNTY: *1/4 mi. N Marble, 8000 ft.,* 1 (KU); Marble, 1 (DMNH); *Sylvanite Basin, 6 mi. N Gothic,* 2 (KU); Copper Lake, 2 (1 CM, 1 USNM); *West Muddy Creek, sec. 20, T. 12 S, R. 89 W,* 2 (WC); *sec. 21, T. 12 S, R. 89 W,* 1 (WC); *9 mi. N Crested Butte, 11,000 ft.,* 1 (KU); *Gothic Primitive Area, 10,000 ft.,* 3 (UMMZ); *Quigley Creek, Gothic Natural Area,* 1 (UMMZ); *7 mi. N Crested Butte, 9500 ft.,* 2 (KU); *sec. 35, T. 12 S, R. 89 W,* 3 (WC); *2 mi. W Gothic,* 1 (UNM); *Mount Gothic,* 4 (ANSP); *Gothic, 9500 ft.,* 60 (11 ANSP, 5 AMNH, 12 KU, 7 UNM, 25 USNM); *1/2 mi. S Rocky Mountain Biological Laboratory,* 2 (AMNH); *Lake Irwin, 10,300 ft.,* 1 (WSC); *Irwin, 10,700 ft.,* 1 (WC); Crested Butte, 9000 ft., 58 (2 AMNH, 1 CSU, 2 KU, 2 MCZ, 51 WC); Taylor Park, 5 (DMNH); *near Beckwith Pass,* 3 (KU); *2 mi. S, 9 mi. E*

Crested Butte, 9400 ft., 1 (KU); *3 mi. S, 6 1/2 mi. E Crested Butte, 9200 ft.,* 3 (KU); *Round Mountain,* 1 (WSC); 23 mi. NW Gunnison, 1 (WSC); *Spring Creek, Cochetopa [Gunnison] National Forest,* 1 (USNM); *sec. 36, T. 15 S, R. 85 W,* 2 (UMMZ); *3 mi. N Almont, 8300 ft.,* 5 (KU); Almont, 2 (USNM); *1 mi. SW Almont,* 2 (KU); *6 mi. N Gunnison,* 1 (WSC); *Lost Canyon,* 1 (WSC); *5 1/2 mi. NE Gunnison,* 2 (WSC); *Biebel Spring, 5 2/10 mi. NE Gunnison, 7820 ft.,* 2 (WSC); *33 mi. W Gunnison,* 1 (CM); *7 1/2 mi. W Gunnison, 7050 ft.,* 9 (FWS); *W of Gunnison,* 1 (WSC); *3 mi. E Gunnison,* 1 (KU); Antelope Creek, 1 mi. WSW Gunnison, 1 (WSC); *6 mi. N U. S. Highway 50 on Dry Creek Road,* 3 (WSC); *1 mi. S Gunnison,* 9 (WSC); *2 mi. S Gunnison,* 3 (WSC); Black Mesa, 9 mi. NNW Sapinero, 9500 ft., 2 (KU); *Black Mesa,* 3 (CU); *8 mi. NW Sapinero,* 1 (USNM); *Forest Reserve Camp, sec. 7, T. 49 N, R. 4 W,* 5 (1 AMNH, 4 WC); *3 mi. S, 6 mi. W Gunnison,* 2 (KU); *4 mi. W Sapinero,* 6 (KU); Sapinero, 3 (2 DMNH, 1 USNM); 5 mi. S Parlin, 6 (FWS); *10 mi. SSE Gunnison, 8500 ft.,* 5 (FWS); Lake Fork Planting Area, 1 (USNM); *no locality other than county,* 2 (ANSP); *John Smith Ranger Station, Cochetopa National Forest* (not found), 1 (USNM). CHAFFEE COUNTY: *10 mi. NE Buena Vista,* 1 (UMMZ); Buena Vista, 7 (UMMZ); base of Mount Princeton, 5 (CU); Salida, 7300 ft., 8 (3 AMNH, 1 USNM, 4 WC); *10 mi. SW Salida,* 30 (8 FWS, 22 KU); near Poncha Pass, 8750 ft., 1 (WC). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 3 (FWS); *9 mi. NW Florissant, 8900 ft.,* 1 (FWS); *7 mi. NNE Florissant, 8900 ft.,* 5 (FWS); *Florissant,* 1 (CSU); Divide, 9200 ft., 5 (1 AMNH, 4 WC); *Glen Cove, Pikes Peak, 11,250 ft.,* 5 (UMMZ); 5 mi. S Victor, 4 (UNM). EL PASO COUNTY: Bear Creek, 8300 ft., 4 (1 AMNH, 3 WC); *E end Strickler Tunnel, 11,560 ft.,* 3 (WC); *Lake Moraine,* 5 (1 AMNH, 4 WC); *near Lake Moraine,* 2 (WC). MONTROSE COUNTY: near mouth of Dry Creek, 2 (CU); *tributary of Cushman Creek, 7000 ft.,* 7 (CU); *Cushman Creek, 7000 ft.,* 7 (CU); 17 mi. SW Delta, 2 (DMNH); 8 mi. W Olathe, 3 (DMNH); *North Rim Campground, Black Canyon of the Gunnison National Monument,* 3 (2 CNM, 1 CU); *1/2 mi. E North Rim Campground,* 2 (CNM); *North Rim Headquarters,* 8 (CU); South Rim Headquarters, 8 (CU); *La Sal Mountains,* 4 (DMNH); *7 1/2 mi. W Montrose, 6000 ft.,* 1 (KU); Montrose, 8 (2 AMNH, 4 DMNH, 2 USNM); *5 mi. E Montrose,* 1 (UNM); *3 mi. S, 30 mi. W Montrose,* 2 (KU); *SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft.,* 5 (KU); *NW 1/4 sec. 21, T. 48 N, R. 13 W, 9000 ft.,* 2 (KU); *West Paradox Valley,* 14 (DMNH); La Sal Cañon, near Paradox, 1 (SC); *2 mi. E Paradox,* 1 (DMNH); about 13 mi. N, 7 mi. E Norwood, 8400 ft., 6 (KU); Bedrock, 3 (WC); Nucla, 2 (SC); *Naturita,* 1 (USNM); *Coventry,* 6800 ft., 19 (3 AMNH, 5 SC, 2 USNM, 9 WC); *no locality other than county,* 7 (USNM); *Jackson Ranger Station, Uncompahgre National Forest* (not found), 5 (SC). OURAY COUNTY: 2 mi. N Ridgway, 7200 ft., 1 (KU); Red Mountain Pass, 10 (SC). SAN MIGUEL COUNTY: *Norwood,* 1 (SC); 2 1/2 mi. E Norwood, 1 (CSU); Placerville, 1 (SC). SAGUACHE COUNTY: Villa Grove, 1 (WC); *4 mi. N, 17 mi. W Saguache, 8500 ft.,* 1 (KU); 3 mi. N, 20 mi. W Saguache, 9050 ft., 2 (KU); *3 mi. N, 16 mi. W Saguache, 8500 ft.,* 1 (KU); 2 mi. N. 32 mi. W Saguache, 9800 ft., 2 (KU); Saguache, 6 (DMNH); *2 mi. N, 2 mi. E Crestone, 8300 ft.,* 9 (KU); *2 1/2 mi. E Crestone, 8500 ft.,* 6 (KU); *1 1/2 mi. N Crestone, 8050 ft.,* 14 (KU); Crestone, 1 (WC); 11 mi. SW Saguache, 7 (DMNH); *10 mi. S Saguache,* 1 (FWS); 11 mi. S Saguache, 1 (DMNH); *5 mi. NW Hooper,* 31 (5 AMNH, 26 DMNH); *Madenos [Medano] Cañon, 1 mi. above Herard's,* 1 (WC); *9 mi. E Center, 7600 ft.,* 37 (AMNH); *Mosca Pass Trail,* 1 (GSDNM). FREMONT COUNTY: Howard, 1 (WC); 3 1/2 mi. S Coaldale, 10 (FMNH); between Rito and Hillside, 1 (WC). CUSTER COUNTY: Hardscrabble Canyon, 7 mi. above Wetmore, 2 (WC); Westcliffe, 7800 ft., 2 (WC); Querida, 9000 ft., 1 (WC); *1 1/2 mi. N, 1 1/2 mi. W Fairview, 9000 ft.,* 4 (KU); Amythyst Creek, above Lake Isabel, 1 (WC); *1 1/2 mi. SW San Isabel City, 8900 ft.,* 1 (KU). PUEBLO COUNTY: 12 mi. W Pueblo, 1 (SCSC); 5 mi. W Buelah, 1 (SCSC). DOLORES COUNTY: S slope Lone Cone, 5 (SC); Mount Wilson, 2 (CU); 1 mi. N Cahone, 6900 ft., 3 (KU); *sec. 13, T. 40 N, R. 13 W, 8100 ft.,* 1 (KU); 5 mi. N, 3 mi. E Stoner, 4 (KU); *2 mi. S, 4 mi. W Cahone, 7000 ft.,* 3 (KU). SAN JUAN COUNTY: *Mineral Creek Campground, San Juan National Forest,* 2 (CSU); *Silverton,* 4 (USNM); 6 1/2 mi. SW Silverton, 9900 ft., 3 (KU). HINSDALE COUNTY: *1 mi. W Lake City,* 3 (KU); Lake City, 10 (USNM); 7 mi. S, 2 mi. W Lake City, 9000 ft., 4 (KU); Hermit, 2 (USNM); Ruby Lake, 1 (USNM). MINERAL COUNTY: 3 mi. E Creede, 2 (KU); 4 mi. S, 4 mi. W Creede, 8800 ft., 7 (KU); *Santa Maria Lake,* 3 (USNM); *Wagon Wheel Gap,* 11 (1 MCZ, 10 WC); 4 mi. S, 6 mi. E Wagon Wheel Gap, 8500 ft., 10 (KU); 3 mi. N Spar City, 8800 ft., 3 (KU); 23 mi. S, 11 mi. E Creede, 9300 ft., 4 (KU). RIO GRANDE COUNTY: Del Norte, 1 (USNM); *3 mi. S, 2 1/2 mi. W South Fork, 8800 ft.,* 4 (KU); *3 mi. S, 2 mi. W South Fork, 8850 ft.,* 1 (KU); 6 mi. S, 1 mi. W South Fork, 8900 ft., 2 (KU); *Windy Mountain, 11,000 ft.,* 2 (UI); 8 mi. S, 11 mi. W Monte Vista, 7 (UI); 8 mi. S Monte Vista, 7660 ft., 61 (UI). ALAMOSA COUNTY: Medano Ranch, 15 mi. NE Mosca, 7700 ft., 4 (2 USNM, 2 WC); *N of campground, Great Sand Dunes National Monument,* 1 (CU); *campground, Great Sand Dunes National Monument,* 19 (CU); Mosca Pass, 8500 ft., 2 (KU); *NE Alamosa County,* 5 (FWS); Hooper, 1 (WC); *24 mi. E Hooper, 8500 ft.,* 6 (AMNH); *San Luis Lake, 7680 ft.,* 7 (4 KU, 3 WC); Mosca, 7572 ft., 4 (2 AMNH, 2 WC); *3 mi. S Great Sand Dunes National Monument,* 2 (GSDNM); *6 mi. S, 3 mi. W Great Sand Dunes National Monument,* 3 (KU); *7 mi. S Great Sand Dunes National Monu-*

ment, 7800 ft., 6 (KU); *Uracca [Verracca?] Pioneer Cemetery, 8800 ft.,* 3 (KU); SW of Blanca Peak, 12,300 ft., 1 (CU); 1 mi. N, 5 mi. E Alamosa, 1 (ASC); 5 mi. W Alamosa, 1 (ASC); *SE Alamosa County,* 1 (FWS). HUERFANO COUNTY: Muddy Creek, 8300 ft., 1 (WC); 1 mi. W Gardner, 1 (DMNH); E of La Veta Pass, 1 (CSU); *8 mi. W Walsenburg,* 5 (DMNH); Walsenburg, 6 (2 AMNH, 4 DMNH); *1 mi. S, 2 mi. W Walsenburg, 6400 ft.,* 6 (KU); *Dog Spring Arroyo, 5 mi. N La Veta,* 2 (SC); *5 mi. N La Veta,* 1 (CU); La Veta, 9 (UMMZ); East Spanish Peak, 10,500 ft., 1 (CU); *Apishapa Pass, West Spanish Peak,* 3 (CU); *"Spanish Rocks,"* 3 (USNM); *4 mi. S Cucharas Camps,* 5 (KU); 5 mi. S, 1 mi. W Cucharas Camps, 10,000 ft., 20 (KU). MONTEZUMA COUNTY: Stoner, 4 (SC); Ackmen, 1 (FMNH); *7 mi. N Dolores,* 3 (UNM); *Yellowjacket,* 15 (14 CU, 1 SC); *1 mi. NW Dolores, 7000 ft.,* 2 (UI); *N of Cortez,* 1 (CSU); Cortez, 12 (4 AMNH, 8 CSU); *Mancos,* 9 (SC); Ashbaugh's Ranch [Moqui], 4 (2 AMNH, 1 USNM, 1 WC); *S of Cortez,* 2 (WC); *2 mi. S, 24 mi. W Cortez, 4850 ft.,* 1 (KU); *North End, Mesa Verde National Park,* 97 (KU); *Upper Well, Prater Canyon, 8525 ft.,* 2 (KU); *Park Point,* 31 (KU); *Prater Canyon, 7600 ft.,* 45 (KU); *1 1/2 mi. E Water's Cabin, 6400 ft.,* 16 (KU); *sec. 27, head East Fork Navajo Canyon, 7900 ft.,* 9 (KU); *3 mi. N Rock Springs,* 8 (KU); *Morfield Canyon, 7600 ft.,* 40 (KU); Ute Peak, 11 (DMNH); *2 mi. NNW Rock Springs,* 2 (KU); *Far View Ruins,* 19 (KU); *Far View Point,* 2 (KU); *1 mi. NNW Rock Springs,* 5 (KU); *1/2 mi. NNW Rock Springs,* 3 (KU); *W bank Mancos River,* 20 (KU); *Mancos River, 6200 ft.,* 5 (KU); *Mesa Verde National Park,* 12 (6 DMNH, 6 KU); Headquarters, Mesa Verde National Park, 7000 ft., 1 (KU); *Mesa Verde, 25 mi. SW Mancos,* 1 (USNM); *Spruce Tree House,* 3 (DMNH); *Balcony House,* 1 (DMNH); San Juan River, near Four Corners, 13 (DMNH). LA PLATA COUNTY: *8 mi. N, 2 mi. E Hesperus,* 4 (UI); Bayfield, 1 (USNM); *1 mi. NW Florida, 6700 ft.,* 1 (KU); Florida, 6800 ft., 7 (2 FMNH, 5 KU); Bondad, 7 (DMNH); *Allison,* 6 (UNM). ARCHULETA COUNTY: Gordon Creek, near junction with Piedra River, 10 (UNM); Pagosa Springs, 4 (USNM); *Devil's Creek, near Dyke,* 3 (DMNH); Chimney Rock, 1 (UNM); *4/10 mi. S junction Colorado Highway 151 and U. S. Highway 160,* 3 (UNM); *1 mi. S, 1 1/4 mi. E Chimney Rock,* 4 (UNM); *Archuleta Cañon,* 5 (UNM); mouth of Archuleta Cañon, 5 (UNM); Upper Navajo River, 2 (DMNH); *Navajo River,* 24 (DMNH); *6 1/2 mi. S, 5 mi. W Chimney Rock,* 3 (UNM); Chromo, 5 (DMNH); *1 mi. S, 2 mi. W Chromo,* 1 (KU); 1 mi. N, 2 mi. W Juanita, 10 (UNM); Arboles, 1 (USNM); *E side San Juan River, NW 1/4 sec. 21, T. 32 N, R. 5 W,* 6 (UNM); *NE 1/4 SE 1/4 sec. 17, T. 32 N, R. 4 W,* 8 (UNM); *NE 1/4, SE 1/4 sec. 18, T. 32 N, R. 4 W,* 1 (UNM). CONEJOS COUNTY: *1/2 mi. N, 1 mi. W Platoro, 9500 ft.,* 2 (KU); Platoro, 3 (FHSC); *1 mi. SW Platoro,* 2 (FHSC); *"3-5 mi. SE Platoro,"* 38 (FHSC); 26 mi. SW Alamosa, 1 (ASC); *1 mi. N, 14 mi. W Antonito, 8450 ft.,* 6 (KU); Antonito, 2 (USNM); Conejos River, 8300 ft., 1 (USNM); *Conejos River,* 3 (CSU); *5 mi. S, 25 mi. W Antonito, 9600 ft.,* 2 (KU); *5 mi. S, 24 mi. W Antonito, 9600 ft.,* 1 (KU); Osier, 1 (DMNH). COSTILLA COUNTY: *Blanca,* 10 (UI); *15 mi. W Fort Garland,* 20 (KU); *W edge of Fort Garland,* 1 (CU); Fort Garland, 6 (2 UMMZ, 4 USNM); 16 mi. E Fort Garland, 1 (CSU); *near Old Fort Garland,* 1 (CU); *1 mi. SW Fort Garland, 7800 ft.,* 3 (AMNH); *5 mi. SSE Fort Garland, 7850 ft.,* 1 (AMNH); *5 mi. S Fort Garland, 7850 ft.,* 4 (AMNH); *8 mi. S, 2 mi. E Fort Garland, 8000 ft.,* 12 (KU); *3 mi. W San Acacio,* 3 (WC); San Acacio, 2 (WC); Culebra Cañon, 9100 ft., 1 (WC); near Garcia, 5 (CU). LAS ANIMAS COUNTY: *Trinidad,* 6 (4 DMNH, 2 USNM); 1 mi. S, 7 mi. E Trinidad, 3 (KU); *Fisher Peak, about 8000 ft.,* 1 (USNM).

Additional records: ROUTT COUNTY: Three Forks, 30 mi. above Baggs, Wyoming (J. A. Allen, 1896:243). JACKSON COUNTY: *[near] Lake Agnes* (Yeager, 1950:329). GARFIELD COUNTY: *Trappers Lake* (Yeager, *loc. cit.*). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). GILPIN COUNTY: *Moon Gulch* (Williams, 1955b:224). CLEAR CREEK COUNTY: *2 mi. N Echo Lake* (Brown and Welser, 1968:422). GUNNISON COUNTY: *3 mi. N Almont* (Finley, 1958:591); for details of local distribution in Gunnison County, see Findley and Negus (1953:238) and Durrant and Robinson (1962:250). CHAFFEE COUNTY: *Cottonwood Hot Springs* (Dice, 1933: 2); *6 mi. W Buena Vista* (Dice, *loc. cit.*). MONTROSE COUNTY: *4 mi. SE Uravan* (Brown and Welser, 1968). HUERFANO COUNTY: *8 mi. W La Veta* (Dice, 1933:2). LA PLATA COUNTY: *8 mi. S Ignacio* (Durrant and Dean, 1962:172). ARCHULETA COUNTY: *San Juan River, mile 176* (Durrant and Dean, 1962:172). CONEJOS COUNTY: *Rio Grande* (Coues and Yarrow, 1875:103). COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:282).

Peromyscus leucopus

WHITE-FOOTED MOUSE

Peromyscus leucopus is widespread in the eastern and central United States and northern and eastern Mexico. The Sangre de Cristo Range and the Pikes Peak massif mark the western boundary of the species at that latitude. White-footed mice are abundant in riparian woodlands and brush communities in southeastern Colorado, but no study has been made of the natural history of the species at the boundary of its range.

Unless comparative material is at hand, specimens of *P. l. tornillo* may be confused

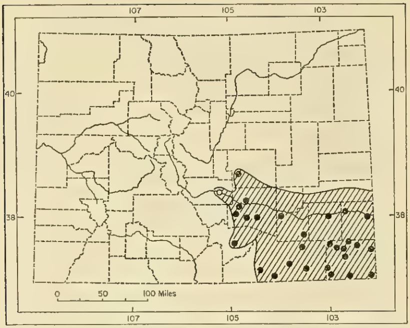


FIG. 68. Distribution of *Peromyscus leucopus tornillo* in Colorado. For explanation of symbols, see p. 9.

with those of *Peromyscus maniculatus nebrascensis*, with which it is sympatric. The color of the two taxa is similar, although in fresh pelage, *P. m. nebrascensis* is buffier and less grayish. The tail of *P. maniculatus* is markedly bicolored, whereas that of *P. leucopus* is only obscurely so. The best suite of characters by which to distinguish *P. leucopus* in Colorado is markedly larger size (see measurements).

Peromyscus leucopus tornillo Mearns

Peromyscus tornillo Mearns, Preliminary diagnoses of new mammals . . . , p. 3, 25 March 1896 (preprint of Proc. U. S. Nat. Mus., 18:445, 23 May 1896); type locality, Rio Grande, about 6 mi. above El Paso, El Paso Co., Texas.

Peromyscus leucopus tornillo, Osgood, N. Amer. Fauna, 28:125, 17 April 1909.

Distribution in Colorado. — Drainage of Arkansas River and affluents, southeastern part of state (Fig. 68).

Comparison.—From *P. l. aridulus*, a subspecies ranging to the north and east of Colorado, *P. l. tornillo* differs in markedly paler color, the sides being brownish gray rather than buffy, and in the obscurity of the middorsal stripe of black-tipped hairs. The two subspecies do not differ appreciably in size.

Measurements.—Average (and extreme) external measurements of five males, followed by those of nine females, all from the vicinity of Two Buttes Reservoir, Baca and Prowers counties, are: 180.2 (168-189), 188.9 (171-201); 80.0 (74-83), 79.6 (68-88); 21.6 (21-23), 22.3 (21-23); 16.6 (16-17), 17.2 (16-18). Those of four males from near Walsenburg, Huerfano County, are: 180.2 (177-183), 84.0 (80-91), 22.5 (22-23), 17.5 (16-19); weight, 28.62 (27.9-30.1). Selected cranial measurements are presented in table 20.

Remarks.—All specimens of *P. leucopus* from Colorado examined by me seemingly are referable to the pale subspecies *P. l. tornillo*, although Osgood (1909:126) considered specimens from the Texas Panhandle and northeastern New Mexico as ". . slightly intermediate between *tornillo* and *aridulus*." Two specimens from Cañon City also were considered to approach *aridulus*; I have not seen those specimens.

Peromyscus leucopus is not known to occur in Colorado north of the Platte-Arkansas Divide. However, Fleharty and Stadel (1968) have documented the occurrence of *P. l. aridulus* in Cheyenne, Sherman, and Wallace counties in extreme northwestern Kansas. Although rather extensive collections of small mammals are available from southern Yuma County, Colorado, *P. leucopus* never has been captured there. If additional collecting (on the upper reaches of the Smoky Hill River, for example) should reveal the presence of *P. leucopus* north of the divide in eastern Colorado, *P. l. aridulus* is the subspecies to be expected. Jones (1964:195) indicated the westernmost extent of the range of *P. leucopus* along the Platte River to be in eastern Lincoln County, Nebraska.

A young adult female (KU 59990) captured 1 mi. S and 7 mi. E of Trinidad has an atypically short, relatively heavy skull with the following measurements: greatest length of skull, 26.3; zygomatic breadth, 14.4; interorbital constriction, 4.4; length of nasals, 10.7.

Records of occurrence.—Specimens examined, 170, distributed as follows: EL PASO COUNTY: Broadmoor Golf Course, 1 (SCSC); *4 mi. S main gate, Camp Carson*, 2 (KU). PUEBLO COUNTY: 5 mi. N Pueblo, 1 (SCSC); *1/2 mi. NNE new campus, Southern Colorado State College, 4700 ft.*, 1 (SCSC); *Overton Road at Fountain Creek*, 1 (SCSC); 8 mi. W Pueblo, 1 (SCSC); *7 1/2 mi. W Pueblo*, 1 (SCSC); *City Park, Pueblo*, 1 (SCSC); *1 mi. S city dump, Pueblo* 1 (SCSC); 8 mi. S, 15 mi. W Pueblo, 1 (SCSC); 25 mi. SE Pueblo, Huerfano [Cucharas] River, 7 (CU); 17 mi. S Pueblo, 1 (CSU). HUER-

TABLE 20

Selected cranial measurements of five species of *Peromyscus.*

Number averaged (or catalog number), sex	Greatest length of skull	Condylobasal length	Zygomatic breadth	Interorbital constriction	Depth of skull	Length of nasals	Length of maxillary toothrow
Peromyscus crinitus auripectus, Moffat and Rio Blanco counties							
Mean, 5 ♂	25.92	24.22	12.72	4.54	8.95	9.98	3.75
Minimum	25.4	23.6	12.6	4.5	8.6	9.6	3.7
Maximum	26.3	24.5	12.9	4.6	9.1	10.4	3.9
Mesa, Montrose and Montezuma counties							
Mean, 8 ♀	25.51	23.81	12.69	4.51	8.82	9.86	3.69
Minimum	24.9	22.9	12.5	4.4	8.6	9.1	3.6
Maximum	26.0	24.4	12.8	4.6	9.0	10.2	3.8
Peromyscus leucopus tornillo, vicinity of Two Buttes Reservoir, Baca and Prowers counties							
Mean, 5 ♂	27.90	26.10	14.44	4.42	10.08	10.90	4.08
Minimum	27.2	25.9	14.1	4.3	9.9	10.3	4.0
Maximum	28.3	26.9	14.8	4.7	10.4	11.0	4.3
Mean, 9 ♀	27.99	25.85	14.51	4.42	10.10	11.06	4.01
Minimum	27.2	25.2	14.0	4.3	10.0	10.6	3.7
Maximum	28.7	27.2	15.0	4.5	10.4	11.5	4.2
1 mi. S, 2 mi. W Walsenburg, Huerfano County							
Mean, 4 ♂	27.98	26.20	14.08	4.35	10.88	10.00	4.15
Minimum	27.8	26.0	13.7	4.0	10.8	9.7	4.0
Maximum	28.2	26.4	14.3	4.6	11.1	10.4	4.3
Peromyscus boylii rowleyi, Montezuma County							
WC 1412, ♂	27.7	26.0	14.1	4.4	10.1	11.3	4.4
KU 29179, ♂	28.0	26.2	13.9	4.3	10.3	11.9	4.4
KU 34742, ♂	27.9	——	12.7	4.3	11.1	11.3	4.5
Bedrock, Montrose County							
WC 2950, ♀	26.8	25.4	——	4.5	9.6	10.3	4.4
Peromyscus truei truei, Montezuma County							
Mean, 4 ♂	28.90	27.22	13.72	4.50	10.60	11.05	4.25
Minimum	28.5	26.7	13.4	4.4	10.5	10.6	4.1
Maximum	29.2	27.5	14.0	4.6	10.7	11.3	4.5
Mean, 4 ♀	28.56	27.06	13.82	4.52	10.40	11.06	4.24
Minimum	28.0	26.5	13.6	4.4	10.1	10.5	4.1
Maximum	29.2	27.6	14.1	4.7	10.8	11.4	4.4
Peromyscus difficilis nasutus, vicinity of Fort Collins, Larimer County							
CSU 8253, ♂	28.2	26.5	13.8	4.5	——	11.0	4.1
CSU 10459, ♂	28.7	26.4	——	4.6	——	10.6	4.6
CSU 8217, ♀	28.6	27.0	14.2	4.6	9.8	11.2	4.3
CSU 10429, ♀	29.0	26.5	14.2	4.5	——	11.0	4.1

FANO COUNTY: 1 mi. S, 2 mi. W Walsenburg, 6 (KU). OTERO COUNTY: 5 mi. S, 3 mi. E Fowler, 1 (CSU); *1 mi. NW Higbee,* 2 (KU); JJ Ranch, Higbee, 4 (USNM). BENT COUNTY: 2 mi. S, 2 mi. E Hasty, 7 (KU). PROWERS COUNTY: *NW of Lamar,* 2 (WC); N of Lamar, 6 (WC); Holly, 1 (CU); *1 mi. S Holly,* 1 (CSU); *15 mi. N, 4 mi. E Springfield,* 3 (KU); *Two Buttes Peak,* 4500 ft., 3 (KU). LAS ANIMAS COUNTY: 10 mi. N Officer, 1 (DMNH); 11 mi. N, 8 mi. E Branson, 5600 ft., 1 (KU); 3 1/2 mi. S, 5 mi. W Kim, 5 (KU); 1 mi. S, 7 mi. E Trinidad, 5 (KU); Trinchera, 3 (DMNH).

BACA COUNTY: Two Buttes Reservoir, 4200 ft., 14 (1 DMNH, 3 KU, 10 UI); *14 mi. N, 4 mi. E Springfield*, 14 (KU); Gaume's Ranch, 1 (WC); Two Buttes, 50 (DMNH); Williams' Corner, 9 mi. N Springfield, 2 (DMNH); Fred Gold Farm, 11 mi. N, 6 mi. W Springfield, 1 (DMNH); Monon, 1 (AMNH); *N of Springfield*, 5 (WC); Springfield, 2 (1 AMNH, 1 MCZ); Carrizo Mountain, 3 (CU); *Jimmie Creek*, 1 (DMNH); *Furnace [Furnish] Canyon*, 2 (DMNH); Skull Canyon, 1 (CU); Regnier, 4500 ft., 17 (2 KU, 15 DMNH); Craugh Ranch, Cimarron River, 4 (DMNH).

Additional record: Cañon City (Osgood, 1909: 126).

Peromyscus boylii

Brush Mouse

The brush mouse has a rather wide range in Colorado although over much of that area it apparently is not abundant. Durrant and Robinson (1962:251) reported only two specimens in their survey of the Curecanti Reservoir basins and fewer than a score of specimens have been collected in the extensive mammalogical reconnaissance of Mesa Verde National Park.

In Colorado, the brush mouse is an inhabitant of rough, rocky plateaus, mesas and canyons, and typically is found in stands of piñon and juniper or deciduous saxicoline shrubs. The maximum elevation at which specimens have been captured is about 8300 feet in the Upper Arkansas River Valley. The northernmost records of the species in Colorado are from south of Colorado Springs along Fountain Creek, and along the North Fork of the Gunnison River near Somerset. Much of western Colorado provides apparently suitable habitat for brush mice, but *P. boylii* is not known to range north of the Colorado River. Similarly, conditions seem suitable for the species around the periphery of the San Luis Valley, but brush mice are unknown there.

The ecological segregation of *P. boylii* from other Coloradan species of *Peromyscus* would be an interesting subject for intensive study, particularly in view of the fact that in some areas as many as five species (*P. boylii, P. difficilis, P. leucopus, P. maniculatus,* and *P. truei*) may be expected to occur in close proximity to one another, and of these, all but *P. maniculatus* are near the periphery of their respective ranges. Wilson (1968) reported a study of ecological distribution of the above-mentioned five species in the Sandia Mountains of New Mexico.

Superficial observations west of Walsenburg in August 1969 suggested rather strict segregation of the four kinds of *Peromyscus* collected. *P. boylii* was captured beneath piled brush, in shrubby vegetation at the base of a boulder-strewn slope, and in an abandoned woodrat den *(Neotoma mexicana). Peromyscus truei* was taken in well-developed piñon-juniper woodland among large rocks. *Peromyscus leucopus* was abundant in well-watered patches of rank weeds in disturbed riparian situations, whereas *P. maniculatus* was commonly captured in more open, xeric habitats than generally are preferred elsewhere in the state, in company with such species as *Perognathus hispidus* and *Onychomys leucogaster.*

Peromyscus boylii is readily distinguished from other species of the genus *Peromyscus* in Colorado because the tail is longer than the head and body and the ear is relatively short (usually 20 or less).

Peromyscus boylii rowleyi (J. A. Allen)

Sitomys rowleyi J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:76, 28 April 1893; type locality, Noland's Ranch, N side San Juan River, about 1 1/2 mi. N Four Corners, San Juan Co., Utah (see Hall, 1931:2).

P[eromyscus]. b[oylii]. rowleyi, Mearns, Preliminary diagnoses of new mammals . . . , p. 3, 25 May 1896 (preprint of Proc. U.S. Nat. Mus., 19:139, 21 December 1896).

Distribution in Colorado.—In suitable habitat in southeastern and southwestern parts of state (Fig. 69).

Comparison.—From *P. b. utahensis,* a subspecies inhabiting that part of Utah west of the Colorado and Green rivers, *P. b. rowleyi* differs in larger external size, relatively shorter tail, markedly paler, more ochraceous dorsal color, and generally smaller skull (Durrant, 1952:317).

Measurements.—External measurements of three males from southwestern Colorado are: 190, 182, 200; 97, 85, 101; 23, 23, 23; 19, 18, 22. External measurements of females from Bedrock and Walsenburg are: 191, 195; 100, 92, 23, 23; —, 19. Two males weighed 23.8 and 25.9. Cranial measurements are given in table 20.

Remarks.—The distribution of *P. b. row-*

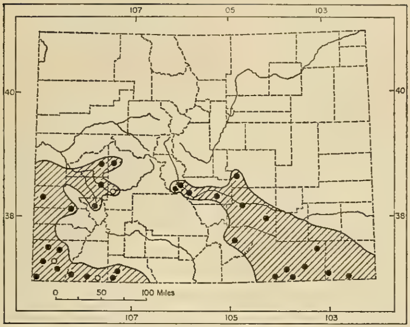


FIG. 69. Distribution of *Peromyscus boylii rowleyi* in Colorado. For explanation of symbols, see p. 9.

leyi in Colorado is interrupted by the San Juan and Sangre de Cristo ranges and the intervening San Luis Valley, but the distribution is continuous in New Mexico. Specimens from southwestern and southeastern Colorado are superficially indistinguishable, but available material does not permit detailed comparison.

To date *P. boylii* has not been captured in that part of Moffat County west of the Green River. The area appears to me to provide habitat for brush mice, and extensive collecting there may reveal its presence. In that event, *P. b. utahensis* is the subspecies to be expected; the race has been reported from Daggett County, Utah (Durrant, 1952:319).

Records of occurrence.—Specimens examined, 110, distributed as follows: DELTA COUNTY: 1 mi. NE Bowie, 6300 ft., 1 (KU). GUNNISON COUNTY: 1 mi. E Somerset, 6100 ft., 1 (KU). CHAFFEE COUNTY: Salida, 1 (WC); 7 mi. SW Salida, 8300 ft., 1 (KU). EL PASO COUNTY: 10 mi. S Colorado Springs, 3 (UMMZ). MONTROSE COUNTY: North Rim, Black Canyon of the Gunnison, 1 (USNM); Bedrock, 1 (WC); Coventry, 5 (USNM). OURAY COUNTY: 2 mi. N Ridgeway, 7200 ft., 2 (KU). FREMONT COUNTY: 1 mi. SE Howard, 1 (SCSC); 2 mi. SW Cañon City, 5400 ft., 1 (KU). PUEBLO COUNTY: 5 mi. W Pueblo, 2 (SCSC); 25 mi. SE Pueblo, 7 (CU). HUERFANO COUNTY: *Walsenburg,* 2 (DMNH); 1 mi. S, 2 mi. W Walsenburg, 2 (KU). MONTEZUMA COUNTY: Ackmen, 3 (FMNH); *Yellowjacket,* 3 (CU); *2 1/2 mi. S, 3 mi. W Yellowjacket,* 2 (CU); 1 mi. NW Dolores, 7 (UI); McElmo Creek, 1 (CSU); *1 mi. S, 20 mi. W Cortez, 5100 ft.,* 1 (KU); *North End, Mesa Verde National Park, 7000 ft.,* 2 (KU); *Mesa Verde,* 1 (USNM); *25 mi. SW Mancos, 7000 ft.,* 1 (USNM); *1 mi. NNW Rock Springs, 7600 ft.,* 1 (KU); 1/2 mi. N Spruce Tree Lodge, 6800 ft., 1 (KU); *Spruce Tree House,* 2 (DMNH); Four Corners, 2 (DMNH). LA PLATA COUNTY: 15 mi. S, 5 mi. E Mancos, 6500 ft., 1 (KU); *2 mi. NE Bondad, 6500 ft.,* 1 (KU); Bondad, 1 (DMNH). ARCHULETA COUNTY: 6 1/2 mi. S, 5 mi. W Chimney Rock, 1 (UNM); 1 mi. N, 2 mi. W Juanita, 18 (UNM); *1/5 mi. N, 1 mi. E Arboles,* 2 (UNM); Arboles, 1 (USNM); *Piedra River, NW 1/4 sec. 4, T. 32 N, R. 5 W,* 2 (UNM); *SE 1/4, SE 1/4 sec. 12, T. 32 N, R. 5 W,* 1 (UNM). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 5200 ft., 4 (WC); 7 1/2 mi. S, 4 mi. W Kim, 2 (KU); 11 mi. N, 8 mi. E Branson, 5600 ft., 1 (KU); Trinchera, 5 (DMNH); Mesa de Maya, 1 (UMMZ). BACA COUNTY: Dodge Ranch, near Carrizo Mountain, 1 (CU); *Furnace [Furnish] Canyon,* 5 (DMNH); 2 mi. N, 7 mi. W Regnier, 4550 ft., 2 (KU); Regnier, 3 (DMNH).

Additional records: GUNNISON COUNTY: 3 mi. NE Cimarron, 7100 ft. (Durrant and Robinson, 1962:251). MONTEZUMA COUNTY: Cortez, 6250 ft. (Warren, 1908b:74). LA PLATA COUNTY: 8 mi. S Ignacio (Durrant and Dean, 1961:173).

Peromyscus truei

PIÑON MOUSE

Peromyscus truei is the most arboreal of Coloradan species of the genus, and is mostly confined to stands of piñon-juniper woodland. The highest elevation from which records of piñon mice are available is Uncompahgre Butte, 8500 feet, in Mesa County. The natural history of *P. truei* in Mesa Verde National Park was discussed in detail by Douglas (1969b). The restriction of the piñon mouse to dwarf conifer woodlands results from a dependence on junipers for nesting sites and preferred winter food. Nests are constructed almost exclusively in hollow branches of species of *Juniperus.* A variety of plant foods is taken in summer, but much of the winter diet consists of juniper "berries." Svihla (1932) studied reproduction and growth of piñon mice from Mesa de Maya in captivity. The subspecies of *P. truei* were revised by Hoffmeister (1951).

Peromyscus truei truei (Shufeldt)

Hesperomys truei Shufeldt, Proc. U.S. Nat. Mus., 8:407, 14 September 1885; type locality, Fort Wingate, McKinley Co., New Mexico.

P[eromyscus]. truei, Thomas, Ann. and Mag. Nat. Hist., ser. 6, 14:365, November 1894.

Distribution in Colorado.—In suitable habitat in southeastern part of state, north to El

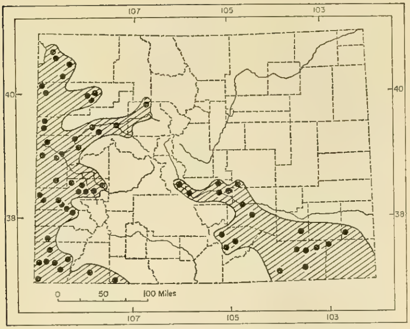


FIG. 70. Distribution of *Peromyscus truei truei* in Colorado. For explanation of symbols, see p. 9.

Paso County; western plateaus and canyons north at least to Escalante Hills and east to Eagle County (Fig. 70).

Measurements.—Average (and extreme) external measurements of four males, followed by those of five females, all from Montezuma County, are: 192.8 (188-197), 192.8 (187-198); 98.8 (92-103), 91.0 (90-92); 24.0 (23-25), 23.2 (23-24); 26.5 (25-28), 26.4 (25-30). Two males weighed 25.0 and 27.2; two females weighed 26.3 and 26.5. Representative cranial measurements are presented in table 20.

Records of occurrence.—Specimens examined, 271, distributed as follows: MOFFAT COUNTY: Escalante Hills, 20 mi. SE Ladore, 3 (USNM); Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 1 (DMNH); *Douglas Spring, 6700 ft.*, 9 (3 USNM, 6 WC); Lily, 4 (3 DMNH, 1 USNM); *Yampa River, 5 mi. NW Cross Mountain,* 3 (CM); *S bank Yampa River, 4 mi. NNW Cross Mountain,* 3 (CM); Elk Springs, 1 (USNM); *[Little] Snake River,* 1 (DMNH). RIO BLANCO COUNTY: 11 mi. N, 11 mi. W Rangely, 6000 ft., 1 (KU); 6 mi. NE Meeker, 4 (CM); 5 mi. W Rangely, 5600 ft., 2 (USNM); N side White River, 4 mi. W Meeker, 3 (CM); Grand Hogback, 5 mi. S Meeker, 12 (CM). GARFIELD COUNTY: Atchee, 6600 ft., 1 (WC); Glenwood Springs, 1 (USNM); 8 mi. W Rifle, 3 (2 KU, 1 USNM); 12 mi. SE Rifle, 1 (FMNH); 20 mi. N Mack, 2 (CM). EAGLE COUNTY: McCoy, 1 (USNM). MESA COUNTY: De Beque, 1 (USNM); Mack, 3 (WC); *1 mi. SE Mack, 4600 ft.*, 1 (KU); Plateau Creek, 5 mi. E Tunnel, 2 (USNM); Sieber Ranch, Little Dolores Creek, 4 (WC); *3 mi. W Grand Junction,* 1 (CM); Grand Junction, 3 (FMNH); *warehouse area, Colorado National Monument,* 5 (CU); *1/4 mi. N Coke Ovens Overlook, Colorado National Monument,* 2 (CNM); 1 mi. S entrance ranger station, Colorado National Monument, 10 (CU); Uncompahgre Butte, 8500 ft., 1 (USNM). CHAFFEE COUNTY: Salida, 6 (WC). EL PASO COUNTY: 20 mi. S Colorado Springs, 2 (CM). MONTROSE COUNTY: 17 mi. SW Delta, 3 (DMNH); North Rim, Black Canyon of the Gunnison National Monument, 3 (CNM); 8 mi. W Olathe, 3 (DMNH); 1 mi. NE Montrose, 5900 ft., 1 (KU); Cushman Creek, 7000 ft., 2 (CU); 7 mi. W Montrose, 6000 ft., 1 (KU); *West Paradox Valley,* 3 (DMNH); Paradox, 1 (SC); *2 mi. E Paradox,* 1 (DMNH); Bedrock, 8 (4 AMNH, 4 WC); Nucla, 2 (SC); 1 mi. E Naturita, 5900 ft., 1 (KU); Coventry, 11 (1 AMNH, 3 USNM, 7 WC); *Naturita Canyon, near Coventry,* 3 (SC). SAN MIGUEL COUNTY: *near Coventry, 6800 ft.*, 5 (3 AMNH, 1 CSU, 1 WC); Norwood, 1 (SC). FREMONT COUNTY: 10 mi. N Cañon City, 4 (CU); Howard, 6714 ft., 1 (WC); 4 1/2 mi. NE Penrose, 3 (UI); Cañon City, 5 (DMNH). PUEBLO COUNTY: 5 mi. W Pueblo, 1 (SCSC); 8 9/10 mi. NE Cedarwood, 5300 ft., 1 (WSC). DOLORES COUNTY: 1 mi. N Cahone, 6900 ft., 1 (KU). HUERFANO COUNTY: 1 mi. W Gardner, 1 (DMNH); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 6 (KU); Dog Springs Arroyo, 5 mi. N La Veta, 1 (CU). OTERO COUNTY: 3 mi. NW Higbee, 2 (KU); *JJ Ranch, Higbee,* 6 (USNM). PROWERS COUNTY: Rhinehart's Stage Station, 20 mi. S Lamar, 1 (USNM). MONTEZUMA COUNTY: *Ackmen,* 4 (FMNH); Yellowjacket, 2 (CU); *2 1/2 mi. S, 3 mi. W Yellowjacket,* 1 (CU); Mancos River, 7200 ft., 4 (KU); Ashbaugh's Ranch [Moqui], 5350 ft., 7 (3 AMNH, 1 USNM, 3 WC); *5 mi. E Cortez,* 3 (CM); 1 mi. S, 22 mi. W Cortez, 5000 ft., 1 (KU); McElmo Creek, S of Cortez, 2 (WC); *North End, Mesa Verde National Park, 7000 ft.*, 13 (KU); *Far View Ruins, 7700 ft.*, 3 (KU); *Far View Point,* 4 (KU); *1/4 mi. S Far View Ruins,* 2 (KU); *Park Well, 7450 ft.*, 1 (KU); *1/2 mi. NNW Rock Springs, 7500 ft.*, 2 (KU); *Rock Springs, 7500 ft.*, 5 (KU); Headquarters, Mesa Verde National Park, 7000 ft., 1 (KU); *NE 1/4 sec. 22, T. 34 N, R. 15 W, 7025 ft.*, 2 (CSU); *Square Tower House, 6700 ft.*, 1 (KU); Four Corners, 1 (DMNH). LA PLATA COUNTY: 9 mi. S Durango, 2 (CSU). ARCHULETA COUNTY: Piedra River, NW 1/4 sec. 4, T. 32 N, R. 5 W, 1 (UNM). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 5000 ft., 3 (WC); junction Plum and Chacuacho creeks, 10 (CU); 10 mi. N Officer, 5 (DMNH); 3 1/2 mi. S, 5 mi. W Kim, 2 (KU); *7 1/2 mi. S, 4 mi. W Kim,* 4 (KU); *Mesa de Maya,* 2 (UMMZ). BACA COUNTY: Gaume's Ranch, 6 (1 AMNH, 1 USNM, 4 WC); *no locality other than county,* 1 (MCZ).

Additional record: MONTROSE COUNTY: *4 mi. SE Uravan* (Brown and Welser, 1968:422).

Peromyscus difficilis

ROCK MOUSE

Peromyscus difficilis occurs in areas of broken rock in canyons and on foothills and hogbacks of the Front Range, particularly where stands of *Cercocarpus* or *Quercus,* or woodlands of *Pinus ponderosa* and *Juniperus scopulorum,* predominate. Farther south, piñon woodland is characteristic habitat. The highest elevation from which *P. difficilis* is known in the Front Range is slightly more than 7500 feet, on the west side of Estes Park. Access to the suitable habitat of margins of the park probably is through the relatively xeric canyon of the Big Thompson River rather than the more mesic valleys entering the southern end of the park. In the Sangre de Cristo Range, the species has been captured at elevations of 8500 feet. The lowest locality at which the rock mouse has been captured is about 4500 feet, along the Oklahoma boundary. An autecological study of the rock mouse in Larimer County emphasizing reproduction and habitat preferences was reported by Cinq-Mars and Brown (1969). The taxonomy of *P. difficilis* was reviewed by Hoffmeister and de la Torre (1961).

From *Peromyscus truei,* with which *P. difficilis* is partially sympatric in Colorado, the latter species differs in shorter ear, relatively longer tail, relatively longer rostrum, smaller auditory bullae, and more grayish (less buffy) color.

Peromyscus difficilis nasutus (J. A. Allen)

Vesperimus nasutus J. A. Allen, Bull. Amer. Mus. Nat. Hist., 3:299, 30 June 1891; type locality, Estes Park, Larimer Co., Colorado.

Peromyscus difficilis nasutus, Hoffmeister and de la Torre, Jour. Mamm., 42:7, 20 February 1961.

Distribution in Colorado.—Rocky sites at moderate elevations in and near Front and Sangre de Cristo ranges (Fig. 71).

Measurements.—External measurements of two males and two females from Larimer County are: 171, 182, 200, 200; 86, 80, 90, 100; 22, 22, 22, 22; —, 24, 22, 22; weight, —, 28.8, 29.0, —. Selected cranial measurements are presented in table 20.

Remarks.—Anderson (1961:53) reported as *P. difficilis* an immature male (KU 69413) from 1 mi. NNW of Rock Springs, Mesa Verde National Park. The ear is as long (23) as that of any adult rock mouse examined, but the tail is relatively longer than that of either *P. truei* or *P. difficilis.* I judge the specimen to represent *P. boylii,* despite the great recorded length of the ear. In my judgment, then, there are no *bona fide* records of *P. difficilis* west of the San Juan Mountains in Colorado, despite an abundance of seemingly suitable habitat.

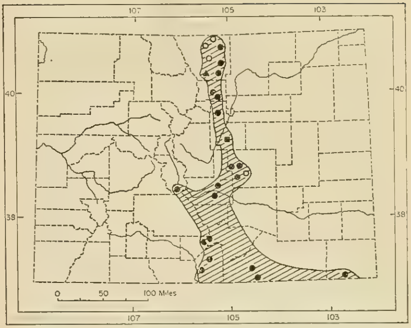


FIG. 71. Distribution of *Peromyscus difficilis nasutus* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 233, distributed as follows: LARIMER COUNTY: 18 mi. N Fort Collins, 1 (CSU); *1/2 mi. N, 1/4 mi. E Livermore,* 1 (CSU); *1 mi. N Owl Canyon,* 2 (CSU); *Owl Canyon,* 13 (2 CSU, 11 UI); *Poudre Canyon, 15 mi. NW Fort Collins,* 1 (KU); *14 mi. NW Fort Collins,* 4 (USNM); *sec. 9, T. 8 N, R. 71 W,* 1 (CSU); *5 mi. W Laporte,* 1 (CSU); *1 mi. W Laporte,* 1 (CSU); *Rist Canyon, 3 mi. W Bellvue,* 1 (UI); *2 mi. above Bellvue,* 1 (CSU); *6 mi. NW Fort Collins,* 2 (UI); *5 mi. NW Fort Collins,* 1 (CSU); *4 3/4 mi. NW Fort Collins,* 1 (CSU); *2 1/4 mi. N Fort Collins,* 1 (CSU); *2 mi. N Dixon Dam,* 2 (CSU); *3 mi. N, 8 mi. W Fort Collins, 5300 ft.,* 1 (CSU); *1 mi. N, 3 mi. W Fort Collins,* 1 (CSU); *6 mi. W Fort Collins,* 1 (CSU); *5 mi. W Fort Collins,* 3 (CSU); *4 4/10 mi. W Fort Collins,* 4 (CSU); *4 mi. W Fort Collins,* 1 (CSU); *3 3/4 mi. W Fort Collins,* 2 (CSU); *3 1/2 mi. W Fort Collins,* 3 (CSU); *3 mi. W Fort Collins,* 1 (CSU); *2 1/2 mi. W Fort Collins, 5300 ft.,* 1 (CSU); *1 mi. S, 4 mi. W Fort Collins,* 6 (CSU); *4 mi. SW Fort Collins,* 3 (CSU); *4 1/2 mi. SW Fort Collins,* 2 (CSU); *sec. 19, T. 7 N, R. 69 W,* 2 (CSU); *3 mi. S, 2 mi. W Fort Collins,* 1 (CSU); *5 mi. SW Fort Collins,* 17 (1 CSU, 16 UI); *4 mi. S, 6 mi. W Fort Collins,* 2 (CSU); *Spring Canyon Dam,* 7 (CSU); 5 mi. S Fort Collins, 5200 ft., 1 (CSU); *sec. 22, T. 6 N, R. 80 W,* 1 (CSU); Estes Park, 7 (USNM); *rocks behind Superintendent's House, Rocky Mountain National Park,* 1 (RMNP); 1 mi. N Carter Lake, 1 (CSU). BOULDER COUNTY: Gold Hill, 9 (USNM); *1 mi. S, 2 mi. E Gold Hill, 7100 ft.,* 2 (KU); *N of Boulder,* 3 (CU); *3 1/10 mi. W Boulder,* 1 (CU); *mouth of Boulder Canyon,* 1 (CU); Boulder, 21 (1 CU, 12 FMNH, 3 ANSP, 5 USNM); *Boulder Canyon, W of Fourmile Canyon,* 1 (CU); *Gregory Canyon, 6000 ft.,* 14 (CU); *Mount Sanitas,* 8 (CU); *1 mi. E Gross Dam,* 1 (CU). JEFFERSON COUNTY: *1 1/2 mi. NW Golden, 6200 ft.,* 3 (KU); Golden, 2 (DMNH); *Table Mountain,* 2 (DMNH). DOUGLAS COUNTY: no locality other than county, 2 (1 DMNH, 1 KU). CHAFFEE COUNTY: 10 mi. SW Salida, 7100 ft., 1 (FWS). EL PASO COUNTY: Ute Pass, 6500 ft., 1 (CSU); *3 mi. N Colorado Springs,* 14 (WC); *Manitou,* 4 (UMMZ); 3 mi. NE Colorado Springs, 2 (WC); *1/2 mi. S Bear Creek, near Colorado Springs,* 1 (WC); *Colorado Springs,* 3 (1 CSU, 2 MCZ); *Hunter's Creek, near Colorado Springs,* 3 (1 AMNH, 2 WC); *5 mi. SW Colorado Springs, 7000 ft.,* 1 (UMMZ); *Van Andert's Spring, Little Fountain Creek,* 1 (WC); 10 mi. S Colorado Springs, 6500 ft., 1 (UMMZ). FREMONT COUNTY: 10 mi. N Cañon City, 2 (CU); *Cañon City,* 1 (USNM); 2 mi. SW Cañon City, 5400 ft., 2 (KU). ALAMOSA COUNTY: 24 mi. E Hooper, 8500 ft., 6 (5 DMNH, 1 KU); [below] Mosca Pass, 3/4 mi. W Headquarters, Great Sand Dunes National Monument, 8500 ft., 3 (KU). COSTILLA COUNTY: 5 mi. SSE Fort Garland, 4 (AMNH); 3 mi. W San Acacio, 3 (WC); *S of San Acacio,* 1 (WC). LAS ANIMAS COUNTY: Trinidad, 10 (1 DMNH, 9 USNM); 1 mi. W Raton Pass, 4 (UNM). BACA COUNTY: Regnier, 4500 ft., 1 (KU).

Additional records (Cinq-Mars and Brown, 1969: 211, unless otherwise noted): LARIMER COUNTY: Dale Creek, 1 mi. S Colorado-Wyoming boundary; Trail Creek Ranch, 15 1/2 mi. NW Livermore; 1 mi. W junction Poudre Canyon Road [Colorado Highway 14] and Pingree Park Road. EL PASO COUNTY: 14 mi. E Fountain (Banta and Norris, 1968:194).

Onychomys leucogaster

NORTHERN GRASSHOPPER MOUSE

The northern grasshopper mouse is widespread in Colorado in semiarid grasslands and shrublands. The highest elevations at which specimens have been taken in the state are approximately 7900 feet in the Wet Mountain Valley and the San Luis Valley, and 8000 feet in North Park. Areas of moderately friable sandy loam seem to be preferred over those with heavier soils or extremely sandy substrates. Grasshopper mice occupy abandoned burrow systems of other rodents or construct their own burrows, frequently at the base of acaulescent vegetation or beside fenceposts. The diet consists primarily of arthropods.

Onychomys leucogaster arcticeps Rhoads

Onychomys arcticeps Rhoads, Proc. Acad. Nat. Sci. Philadelphia, 50:194, 3 May 1898; type locality, Clapham, Union Co., New Mexico.

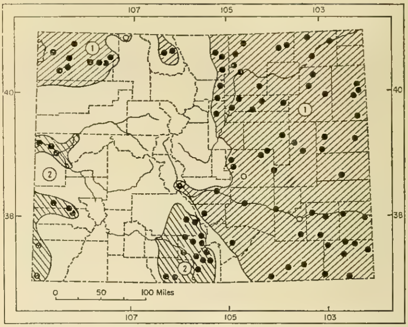


FIG. 72. Distribution of *Onychomys leucogaster* in Colorado. 1. *O. l. arcticeps.* 2. *O. l. pallescens.* For explanation of symbols, see p. 9.

Onychomys leucogaster arcticeps, Hollister, Proc. U.S. Nat. Mus., 47:439, 29 October 1914.

Distribution in Colorado.—In suitable habitat on eastern plains, westward to Wet Mountain Valley and Upper Arkansas Valley; North Park; northwestern Colorado, eastward to Elkhead Mountains (Fig. 72).

Comparison.—From *O. l. pallescens,* the subspecies of west-central and southwestern Colorado and the San Luis Valley, *O. l. arcticeps* differs in slightly smaller average external size and duller (less reddish) dorsal color.

Measurements.—Average (and extreme) external and cranial measurements of four males, followed by those of four females, all from east-central Colorado, are: 138.2 (128-151), 145.5 (139-158); 40.2 (34-46), 39.8 (38-42); 22.0 (20-23), 21.8 (20-23); —, 16.7 (16-17); condylobasal length, 26.75 (26.2-27.6), 26.88 (26.2-27.6); zygomatic breadth, 14.50 (13.8-15.2), 14.67 (14.1-15.3); interorbital constriction, 4.55 (4.3-4.7), 4.50 (4.4-4.6); length of maxillary toothrow, 4.60 (4.5-4.7), 4.49 (4.3-4.8). A male from Adams County weighed 37.8.

Remarks.—J. A. Allen (1896:243) reported a single specimen from Three Forks, about 9000 to 9500 feet, on Little Snake River, 30 mi. above Baggs, Wyoming. There is no reason to doubt that locality, but probably the elevation is in error. Three Forks is situated at an elevation of about 7100 feet. Three Forks

Mountain is only slightly more than 9000 feet in elevation, and the prominence is forested and provides habitat unsuitable for grasshopper mice.

Records of occurrence.—Specimens examined, 295, distributed as follows: MOFFAT COUNTY: [Little] Snake River, S of Sunny Peak, 1 (USNM); Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 2 (DMNH); 8 mi. NE Craig, 1 (CM); [Little] Snake River, lower bridge, 1 (USNM); Lay, 1 (USNM); *[Little] Snake River,* 1 (DMNH); 10 mi. W Craig, 1 (CM); *5 mi. W Craig,* 1 (WC); Craig, 1 (WC); 2 mi. SE Cross Mountain, 1 (CM); 1 mi. W Elk Springs, 1 (CM). JACKSON COUNTY: Canadian Creek, 8000 ft., 3 (USNM); *5 mi. E Canadian Creek,* 4 (USNM); 1 mi. W Walden, 1 (CSU). LARIMER COUNTY: *9 mi. N, 3 mi. W Fort Collins,* 1 (CSU); 12 mi. NW Fort Collins, 1 (CSU); *2 mi. N, 4 mi. W Fort Collins, 5200 ft.,* 1 (KU); *1/2 mi. W Fort Collins,* 1 (CSU); Fort Collins, 2 (CSU); Loveland, 13 (USNM). WELD COUNTY: 8 mi. E Pawnee Buttes, 3 (USNM); 11 mi. NE Nunn, 1 (CSU); Horsetail Creek, 17 mi. NW Stoneham, 2 (DMNH); *Central Plains Experiment Station, near Nunn,* 18 (UNM); 3 mi. N, 19 mi. E Fort Collins, 1 (CSU); *13 mi. E Fort Collins,* 2 (CSU); 1/2 mi. E Windsor, 1 (CSC); Greeley, 2 (USNM); Roggen, 1 (FMNH). LOGAN COUNTY: 2 1/2 mi. S, 12 mi. W Peetz, 1 (KU); 4 mi. E Crook, 1 (WSC); Sterling, 4 (USNM). BOULDER COUNTY: Longmont, 1 (USNM); 6 mi. S, 1 1/2 mi. E Boulder, 3 (CU). JEFFERSON COUNTY: Golden, 1 (USNM). ADAMS COUNTY: Barr, 5 (2 DMNH, 1 UI, 2 WC); *Barr Lake,* 1 (DMNH); Leader, 1 (UMMZ); *3 mi. S, 1 mi. W Simpson,* 3 (KU); 25 mi. S Fort Morgan, 3 (UMMZ); *30 mi. S Fort Morgan,* 1 (UMMZ); *5 mi. N Fitzsimmons Hospital,* 1 (CSU); *5 mi. NE Fitzsimmons Hospital,* 2 (DMNH); *3 mi. NE Fitzsimmons Hospital,* 6 (DMNH); *near Fitzsimmons Hospital,* 3 (2 DMNH, 1 SC); Aurora, 3 (1 SC, 2 UNM); 10 mi. E Denver, 7 (DMNH). WASHINGTON COUNTY: 17 mi. S Sterling, 2 (1 CSC, 1 CSU); *16 8/10 mi. N Akron,* 1 (CSU); Akron, 5 (UMMZ); 10 mi. S, 7 mi. E Otis, 1 (CSU); *no locality other than county,* 2 (UMMZ). YUMA COUNTY: 10 mi. N Wray, 4 (DMNH); Wray, 15 (12 DMNH, 3 WC); Dry Willow Creek, 1 (DMNH); Bonny Reservoir, 1 (UI). ELBERT COUNTY: 6 mi. N Riverbend, 8 (CU). LINCOLN COUNTY: Limon, 1 (USNM); Hugo, 2 (USNM); 1/2 mi. S, 6 mi. E Rush, 1 (FHSC); *no locality other than county,* 1 (FWS). KIT CARSON COUNTY: *5 mi. NE Burlington,* 1 (KU); *4 mi. NE Burlington,* 1 (KU); Burlington, 4 (2 UMMZ, 2 USNM); 4 mi. E Flagler, 3 (KU); *4 1/2 mi. E Flagler,* 4 (KU); SE of Loco, 4500 ft., 2 (USNM). CHAFFEE COUNTY: Salida, 2 (1 USNM, 1 WC). EL PASO COUNTY: 2 mi. W Ramah, 4 (KU); 5 mi. E Peyton, 1 (KU); 6 mi. N, 1 mi. W Colorado Springs, 1 (UI); *2 mi. N Colorado Springs,* 1 (WC); *3 mi. NE Colorado Springs,* 5 (1 AMNH, 4 WC); *2 mi. NE Colorado Springs,* 6 (2 AMNH, 4 WC); Colorado Springs, 11 (6 AMNH, 4 MCZ, 1 WC); *near Colorado Springs,* 5 (WC); *E of Colorado Springs,* 1 (WC); *2 mi. E Colorado Springs,* 4 (1 AMNH, 3 WC); *3 mi. E Colorado Springs,* 2 (1 AMNH, 1 WC). CHEYENNE COUNTY: 6 mi. N Cheyenne Wells, 1 (WC); Cheyenne Wells, 3 (1 AMNH, 2 WC); 10 mi. S Firstview, 1 (CU). FREMONT COUNTY: Cañon City, 1 (USNM). CUSTER COUNTY: Westcliffe, 7800 ft., 2 (WC). PUEBLO COUNTY: *6 mi. W Pueblo,* 2 (CSU); *3 mi. W Pueblo, 4800 ft.,* 1 (WSC); Pueblo, 1 (MCZ). CROWLEY COUNTY: 1 mi. N Fowler, 2 (CSU). HUERFANO COUNTY: 3 mi. W Walsenburg, 1 (WC); *1 mi. S, 2 mi. W Walsenburg, 6400 ft.,* 2 (KU). OTERO COUNTY: *4 mi. SE Fowler,* 1 (CSU); JJ Ranch, Higbee, 2 (USNM). BENT COUNTY: Las Animas, 1 (USNM); 2 mi. S, 2 mi. E Hasty, 4 (KU); Rule Creek, 4 (3 FWS, 1 KU). PROWERS COUNTY: *1 mi. S Lamar,* 2 (KU); 1 1/2 mi. S Lamar, 3 (WC); 1 mi. S Holly, 1 (CSU). LAS ANIMAS COUNTY: 3 1/2 mi. S, 5 mi. W Kim, 1 (KU); Mesa de Maya, 2 (UMMZ); Trinchera, 2 (DMNH). BACA COUNTY: *Two Buttes Reservoir,* 2 (UI); Gaume's Ranch, 1 (USNM); 14 mi. N, 4 mi. E Springfield, 1 (KU); Two Buttes, 4 (DMNH); *Fred Gold Farm, 6 mi. W Williams' Corner,* 7 (DMNH); *Williams' Corner, 9 mi. N Springfield,* 2 (DMNH); Monon, 6 (1 MCZ, 5 WC); N of Springfield, 2 (WC); *Jimmie Creek,* 2 (DMNH); Furnace [Furnish] Canyon, 3 (DMNH); Regnier, 6 (DMNH).

Additional records: ROUTT COUNTY: Three Forks, 30 mi. above Baggs, Wyoming (J. A. Allen, 1896:243). DENVER COUNTY: *Denver* (Hollister, 1914:441). EL PASO COUNTY: 14 mi. E Fountain (Norris and Banta, 1965:54). OTERO COUNTY: La Junta (Hollister, 1914:441).

Onychomys leucogaster pallescens Merriam

Onychomys melanophrys pallescens Merriam, N. Amer. Fauna, 3:61, 11 September 1890; type locality, Moki Pueblos, Navajo Co., Arizona.

Onychomys leucogaster pallescens, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:225, 29 June 1895.

Distribution in Colorado.—In suitable habitat in San Luis Valley and at lower elevations in valleys of southwestern and west-central parts of state (Fig. 72).

Comparison.—For comparison with *O. l. arcticeps,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of five males, followed by those of eight females, all from northern Costilla County, are: 149.8 (145-154), 147.8 (134-157); 47.0 (43-52), 47.5 (43-50); 22.8 (22-24), 22.0 (20-23); 18.4 (17-19), 16.9 (16-18); weight (four males, four females), 33.80 (23.5-44.0), 30.20 (27.7-35.5). Representative cranial measurements of four of the above-mentioned males and eight females include: condylobasal length, 26.68 (26.0-27.5), 26.44 (26.0-27.0); zygomatic breadth, 14.90 (14.6-16.0), 14.42 (14.0-15.0); interorbital constriction, 4.82 (4.5-5.0), 4.75 (4.6-5.1); length of maxillary toothrow, 4.44 (4.4-4.5), 4.47 (4.3-4.7).

Remarks.—Cary (1911) referred all Coloradan grasshopper mice available to him to the subspecies *O. l. pallescens*, except for specimens from north of the Yampa River that were considered to represent *O. l. brevicaudus.* Hollister (1914) revised the grasshopper mice, referring specimens from eastern Colorado, North Park, and Moffat County to *O. l. arcticeps,* whereas those from west-central and southwestern Colorado and the San Luis Valley were referred to *O. l. melanophrys. Onychomys l. pallescens* was arranged as a synonym of *O. l. melanophrys.*

Benson (1935b) revived the name *pallescens* for grasshopper mice from northeastern Arizona and adjacent Utah. That usage was maintained by Durrant (1952:327) and is followed herein. Apparently the Colorado and Green rivers effectively separate *pallescens* and *melanophrys* in Utah. Although they are superficially similar, the two subspecies differ in a number of cranial details (see Durrant, 1952:328).

Records of occurrence.—Specimens examined, 64, distributed as follows: MESA COUNTY: *Stateline,* 1 (CM); U.S. Highway 50, 3 mi. E Utah boundary, 2 (AMNH); Fruita, 5 (USNM); 2 mi. W Grand Junction, 2 (DMNH). MONTROSE COUNTY: 5 mi. W Naturita, 2 (USNM); Coventry, 5 (1 USNM, 4 WC). SAN MIGUEL COUNTY: Norwood, 1 (SC). SAGUACHE COUNTY: Moffat, 7568 ft., 1 (WC); Crestone, 7871 ft., 1 (WC). ALAMOSA COUNTY: Hooper, 7566 ft., 3 (WC); San Luis Lakes, 7680 ft., 1 (WC); *Medano Ranch, 15 mi. NE Mosca,* 6 (2 DMNH, 3 USNM, 1 WC); *19 8/10 mi. E Colorado Highway 17 on Colorado Highway 150,* 1 (CU); 22 mi. E Mosca, 1 (AMNH); *Great Sand Dunes National Monument,* 1 (GSDNM); *NE Alamosa County,* 1 (FWS); Alamosa, 1 (UMMZ). MONTEZUMA COUNTY: Ackmen, 2 (FMNH); Four Corners, 1 (DMNH). CONEJOS COUNTY: Conejos River, 8300 ft., 1 (USNM); Antonito, 1 (USNM). COSTILLA COUNTY: 3 mi. NW Fort Garland, 1 (DMNH); *Blanca,* 1 (WC); 15 mi. W Fort Garland, 5 (KU); "Garland," 1 (UMMZ); 5 mi. SSW Fort Garland, 1 (AMNH); *5 mi. SSE Fort Garland,* 10 (AMNH); *5 mi. S Fort Garland,* 1 (AMNH); 8 mi. S, 2 mi. E Fort Garland, 1 (KU); San Acacio, 3 (WC); 2 1/2 mi. S San Acacio, 7737 ft., 1 (CSU).

Additional record: COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:282).

Sigmodon hispidus

Hispid Cotton Rat

Sigmodon hispidus is primarily a mammal of southern United States, Mexico, and Middle America. Within the present century, cotton rats apparently have extended their range westward and northward. Cockrum (1948) documented changes in the range in Kansas, and Jones (1960) reported the species from extreme southeastern Nebraska. The first specimens from Colorado were collected in Baca County in 1946; these were regarded by Goldman and Gardner (1947) as a new subspecies. Their suggestion that a relict population once existed in Colorado would bear investigation, although certainly today Coloradan populations are essentially continuous with those to the south and east. If *S. hispidus* had been established in Colorado for an appreciable length of time, it seems to me curious that the species was not in the extensive collections made by Warren at Monon and near Springfield, or by the Biological Survey at Lamar.

In Colorado, *S. hispidus* is known only from areas of rank grass near streams and reservoirs. In New Mexico, however, hispid cotton rats apparently are not limited so strictly to such habitats (see Mohlenrich, 1961).

Sigmodon hispidus alfredi

Goldman and Gardner

Sigmodon hispidus alfredi Goldman and Gardner, Jour. Mamm., 28:57, 17 February 1947; type locality, I. N. Pruitt Farm, near Williams' Corner, 11 mi. N Springfield, Baca Co., Colorado.

Distribution in Colorado.—In suitable habitat in southeastern part of state (Fig. 73).

Measurements.—External and cranial measurements of two males and mean (and extremes) of six females, all from the vicinity of the type locality, are: 254, 271, 259.3 (244-274); 101, 113, 94.5 (80-105); 31, 34, 30.3 (29-32); greatest length of skull, 36.1, 35.8, 36.00 (35.3-36.7); condylobasal length, 34.5, 33.7, 34.06 (33.1-35.0); zygomatic breadth, 20.4, 20.6, 20.40 (19.9-21.5); interorbital constriction, 5.1, 5.0, 4.78 (4.7-4.9); length of

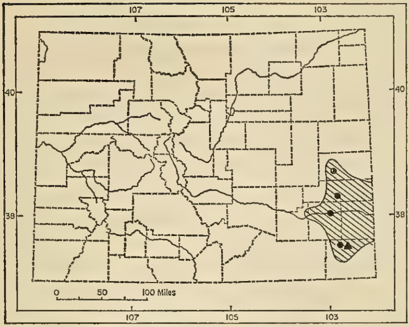


FIG. 73. Distribution of *Sigmodon hispidus alfredi* in Colorado. For explanation of symbols, see p. 9.

nasals, 13.4, 14.1, 14.15 (13.8-15.3); length of maxillary toothrow, 6.2, 6.4, 6.57 (6.3-6.9).

Remarks.—Goldman and Gardner (1947: 57) distinguished *S. h. alfredi* from other named kinds on the basis of small size and cranial details, and on the basis of more pinkish, less yellowish color of the dorsum and sides. The hypodigm available to Goldman and Gardner consisted almost entirely of young animals, subadults and young adults. Most of the material was collected in the spring of 1946, and evidently represented individuals of various ages born the previous year. The small size attributed to *alfredi* and cranial details supposed to be diagnostic (skull rounded, less angular and less massive than in *S. h. berlandieri* or *S. h. texianus*) seem to me to reflect the fact that few adults were available when the subspecies was described.

The color of several individuals from northern Baca County is distinctly pinkish, less yellowish than is usual in *texianus*, although specimens from 2 mi. S and 2 mi. E of Hasty and from 18 mi. N of Lamar do not show the pinkish buff wash. Hansen (1963) referred the latter specimen (CSU 9812) to *texianus* with good reason. Color is an inadequate basis for distinguishing subspecies of *S. hispidus*. Local populations tend to be quite variable in this respect. The color of specimens from southeastern Colorado is well within the range of variation seen in a large series of specimens examined from Greenwood County, Kansas.

The subspecies of *S. hispidus* are in need of revision. When such a study is undertaken, *alfredi* may be found to be (as I suspect) a synonym of *texianus*. On the other hand, the name *alfredi* may be found to apply to cotton rats over a wide range on the Great Plains. In either case, further research probably will contraindicate the conclusion of Goldman and Gardner (1947:58) that *alfredi* is a ". . . long established regional race" restricted to southeastern Colorado. In my judgment, differences between the nominal subspecies *S. h. alfredi* and *S. h. texianus* (as known to me by specimens from eastern Kansas) are insufficient to be of any zoogeographic significance.

Records of occurrence.—Specimens examined, 55, distributed as follows: CHEYENNE COUNTY: 5 mi. E Kit Carson, 1 (DMNH). KIOWA COUNTY: Nee Noshe Reservoir, 18 mi. N Lamar, 1 (CSU). BENT COUNTY: 2 mi. S, 2 mi. E Hasty, 1 (KU). BACA COUNTY: *Two Buttes Reservoir,* 2 (UI); *14 mi. N, 4 mi. E Springfield,* 2 (KU); Fred Gold Farm, 6 mi. W Williams' Corner, 35 (31 DMNH, 4 USNM); I. N. Pruitt Farm, near Williams' Corner, 11 mi. N Springfield, 13 (9 DMNH, 4 USNM).

Neotoma floridana

EASTERN WOODRAT

Neotoma floridana is typically a mammal of the southeastern United States. The western limit of distribution is reached in eastern Colorado, where these woodrats occur on the interfluve between the South Platte and Arkansas rivers. In the northeastern part of the range, near Wray, dens are built among rocky ledges, but farther south and west, dens are commonly found in shrubs or arborescent cactus as well. Over wide areas in eastern Colorado, habitat is unsuitable for *N. floridana,* and populations tend to be localized. Where natural habitat occurs, eastern woodrats commonly move into unoccupied buildings or out-buildings, but apparently the advent of permanent settlement on the plains has not allowed any significant expansion of the range.

Finley (1958) combined an excellent taxonomic review with a thorough comparative ecological study of the six species of the genus *Neotoma* that occur in Colorado. That work has been used freely in drafting the

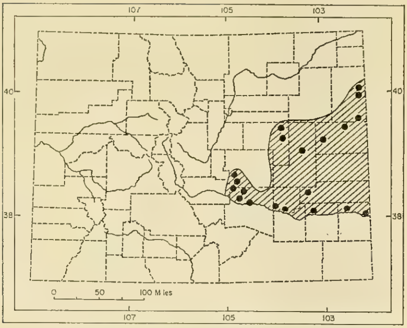


FIG. 74. Distribution of *Neotoma floridana campestris* in Colorado. For explanation of symbols, see p. 9.

present account, and the accounts of other species of woodrats.

Neotoma floridana campestris J. A. Allen

Neotoma campestris J. A. Allen, Bull. Amer. Mus. Nat. Hist., 6:322, 7 November 1894; type locality, Pendennis, Lane Co., Kansas.

Neotoma floridana campestris, Kellogg, Kansas Univ. Mus. Nat. Hist., Publ. 1, Zool. Ser., 1(1):3, 30 January 1914.

Distribution in Colorado.—Plains of east-central part of state, north of Arkansas River to vicinity of Wray, and westward in Arkansas drainage to foothills of Rampart Range (Fig. 74).

Measurements.—Mean (and extreme) external measurements of five males, followed by measurements of three females, all from Yuma County, are: 361.2 (349-373), 368, 369, 356; 141.2 (139-143), 159, 155, 147; 41.8 (41-43), 40, 41, 41; a male weighed 14 oz., a female, 12 oz. For representative cranial measurements, see table 21.

Remarks.—A questionable record (not plotted on Fig. 74) is a specimen (USNM 6320, skull only, sex unknown) collected by Dr. E. Palmer and labelled "Denver, Col. Terr." The skull obviously is of *N. floridana,* but Denver is today well outside the known range of that species. Finley (1958:318) commented on another specimen (USNM 6301, a male, not seen by me) labelled "Denver City," and also collected by Palmer. Finley noted that "it is possible that in [Palmer's] day [ca. 1865] the Florida wood rat did range northwest as far as Denver. In view of the incompleteness of this specimen and its data, however, it seems more likely that the specimen came from some locality on the plains east of Denver" (Finley, *loc. cit.*). Access of *N. floridana* to the immediate vicinity of Denver would seem to me to be precluded by nearly featureless plains to the east and by the range of *Neotoma mexicana* to the south.

Coues (1879:224), commenting on mammals in the Maxwell Collection displayed at the Philadelphia Exposition of 1876, noted of *N. floridana:* "This species also occurs, and comes about the houses like [*Neotoma cinerea*], but the two do not seem to get along well together." The Maxwell Collection was accumulated primarily near Boulder. The implication of the foregoing quotation is that the species in question occurred near the range of *N. cinerea.* Today, only the bushy-tailed and Mexican woodrats occur near Boulder, and perhaps the animal about which Coues remarked was, in fact, *N. mexicana.*

Records of occurrence.—Specimens examined, 58, distributed as follows: DENVER COUNTY: "Denver, Col. Terr.," 1 (USNM—see remarks). YUMA COUNTY: Wray, 17 (4 AMNH, 2 DMNH, 1 USNM, 10 WC); *1 mi. S Wray,* 3 (KU); Boyce Ranch, Dry Willow Creek, 1 (DMNH); *2 mi. W Hale,* 1 (KU); *Bonny Reservoir,* 1 (UI); 1 mi. S, 3 mi. W Hale, 1 (KU). ELBERT COUNTY: 8 mi. NE Agate, 1 (DMNH); Cedar Point, 6 mi. NW Limon, 1 (WC). KIT CARSON COUNTY: Tuttle, 2 (USNM). EL PASO COUNTY: 10 mi. S Colorado Springs, 3 (UMMZ); *1 1/2 mi. SW Fountain, 5700 ft.,* 2 (KU); *2 1/2 mi. SW Fountain, 5700 ft.,* 1 (KU); 3 mi. S, 2 mi. W Fountain, 5600 ft., 1 (KU); 16 mi. W Wigwam, 1 (CU). CROWLEY COUNTY: 3 mi. N Fowler, 4400 ft., 7 (KU); Olney [Springs], 12 (USNM); *T. 22 S, R. 59 W,* 1 (CSU).

Additional records (Cary, 1911:115, unless otherwise noted): LINCOLN COUNTY: Big Sandy Creek, near Hugo. KIT CARSON COUNTY: South Fork Republican River, near Flagler. EL PASO COUNTY: *7 mi. SSE Colorado Springs, 5900 ft.* (Finley, 1958:318). PUEBLO COUNTY: (Warren, 1942:209, unless otherwise noted): *Chico Basin, 20 mi. N Pueblo;* N of Piñon; 6 mi. N, 12 mi. W Pueblo, 5150 ft. (den record, Finley, 1958:318); Pueblo. KIOWA COUNTY: 10 mi. N Arlington. BENT COUNTY: Fort Lyon (J. A. Allen, 1894: 322). PROWERS COUNTY: Arkansas River, S of Chivington; near Holly (Warren, 1910b:112).

TABLE 21
Selected cranial measurements of six species of *Neotoma*.

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital constriction	Length of nasals	Breadth of rostrum	Length of maxillary toothrow
Neotoma floridana campestris, Yuma County							
Mean, 5 ♂	49.26	42.18	26.74	7.06	20.34	8.18	9.74
Minimum	45.8	38.8	26.1	6.7	19.1	8.0	8.8
Maximum	52.5	45.6	27.8	7.6	21.8	9.2	10.3
Mean, 4 ♀	46.77	39.67	25.55	6.70	19.02	8.15	9.60
Minimum	45.7	38.7	25.1	6.5	18.7	8.0	9.3
Maximum	48.0	40.8	26.3	7.0	19.4	8.3	10.1
Neotoma micropus canescens, Las Animas and Baca counties							
Mean, 4 ♂	47.62	40.65	26.55	6.22	18.92	8.45	9.40
Minimum	46.9	39.1	25.4	5.8	18.3	8.0	9.2
Maximum	48.5	42.0	27.4	6.5	19.7	9.3	9.8
Mean, 4 ♀	42.92	37.07	24.70	6.05	17.28	7.45	8.45
Minimum	41.1	39.2	23.8	5.8	16.6	6.9	8.1
Maximum	45.1	35.2	25.6	6.2	18.3	7.7	9.2
Neotoma albigula brevicauda, 1 mi. SW Gateway, Mesa County							
KU 34749, ♂	44.4	37.6	22.5	5.9	17.4	7.7	8.5
KU 34751, ♂	42.5	35.9	22.0	5.9	16.9	7.6	8.8
KU 34750, ♀	39.7	33.8	20.9	5.7	15.9	7.3	8.4
KU 34752, ♀	42.2	36.0	22.1	5.7	16.8	7.5	8.2
Neotoma albigula laplataensis, La Plata County							
KU 34759, ♀	42.7	36.0	22.7	5.7	——	7.3	8.1
KU 34764, ♀	40.2	34.7	21.1	5.7	15.5	7.0	8.0
KU 34765, ♀	41.7	36.0	22.7	5.6	15.9	7.4	8.4
Neotoma albigula warreni, Otero, Prowers, and Baca counties							
Mean, 9 ♂	43.26	37.50	23.53	5.78	17.12	7.72	8.50
Minimum	42.0	36.1	22.5	5.5	16.8	7.4	7.8
Maximum	45.0	39.0	24.7	6.0	17.6	8.0	9.0
Mean, 13 ♀	42.55	36.71	23.35	5.63	16.68	7.47	8.53
Minimum	41.4	35.6	21.9	5.2	15.6	7.0	7.9
Maximum	44.1	38.5	25.0	5.9	17.4	8.1	9.1
Neotoma lepida sanrafaeli, northwestern Mesa County							
KU 29191, ♂	38.4	33.4	20.6	5.3	14.8	6.0	8.6
KU 29192, ♂	37.0	31.4	19.6	5.0	14.7	6.1	8.5
WC 4041, ♂	40.6	35.5	21.8	5.2	15.7	6.5	8.6
Mean, 6 ♀	36.52	30.67	19.45	5.07	14.43	5.83	8.17
Minimum	35.4	30.1	18.6	5.0	13.6	5.7	7.9
Maximum	38.0	31.8	20.0	5.2	15.2	6.3	8.4
Neotoma mexicana fallax, Larimer and Boulder counties							
Mean, 10 ♂	42.68	35.88	23.42	5.39	17.62	6.85	9.16
Minimum	41.7	35.0	22.3	5.2	16.3	6.6	8.8
Maximum	45.3	38.5	24.6	5.6	18.8	7.1	9.5
Mean, 8 ♀	41.83	35.15	22.67	5.30	16.67	6.80	9.11
Minimum	40.5	33.8	21.8	5.1	15.9	6.5	8.7
Maximum	43.6	36.9	23.5	5.5	17.6	7.0	9.4

TABLE 21 (Continued)
Selected cranial measurements of six species of *Neotoma.*

Number averaged (or catalog number), sex	Condylobasal length	Basilar length	Zygomatic breadth	Interorbital constriction	Length of nasals	Breadth of rostrum	Length of maxillary toothrow
Neotoma mexicana inopinata, Mesa and Montrose counties							
Mean, 7 ♀	41.32	35.12	22.27	5.40	17.40	6.74	8.78
Minimum	39.7	33.8	21.2	5.0	16.9	6.6	8.3
Maximum	41.6	36.2	23.5	6.2	18.1	6.9	9.3
Mean, 7 ♂	40.18	33.93	21.98	5.11	16.93	6.64	8.64
Minimum	37.9	32.0	21.0	4.7	15.6	6.2	8.1
Maximum	42.7	35.8	22.9	5.5	18.0	7.0	9.4
La Plata and Archuleta counties							
KU 34804, ♂	42.8	36.4	22.2	5.0	18.0	6.7	8.9
KU 34805, ♂	41.2	34.9	22.7	5.3	16.4	6.6	9.2
KU 34810, ♂	40.4	33.9	22.4	5.2	16.1	6.6	8.1
Mean, 6 ♀	41.43	34.65	22.07	5.23	17.55	6.77	8.92
Minimum	40.5	33.4	21.4	4.8	17.0	6.2	8.7
Maximum	42.3	35.8	23.0	5.6	18.5	7.4	9.3
Neotoma mexicana scopulorum, Prowers and Baca counties							
KU 37138, ♂	43.2	36.5	23.0	5.6	17.9	7.2	9.8
KU 37140, ♂	44.2	37.8	24.4	5.5	18.4	7.1	9.2
KU 37142, ♂	45.4	38.8	23.9	5.2	19.9	6.6	9.7
Mean, 6 ♀	42.73	36.17	22.98	5.18	17.83	7.10	9.37
Minimum	41.0	34.6	22.4	5.0	16.7	6.9	9.0
Maximum	45.0	38.7	23.8	5.4	19.7	7.4	9.7
Neotoma cinerea arizonae, western Moffat County							
CU 4729, ♂	46.1	38.3	24.1	5.7	19.9	7.5	9.4
WC 2421, ♀	44.5	37.9	24.4	5.9	17.9	7.6	9.3
Grand Junction, Mesa County							
WC 997, ♂	43.8	37.2	22.3	5.6	18.2	7.3	9.1
WC 1027, ♂	46.6	40.3	23.5	5.7	19.1	7.6	9.2
Montezuma County							
WC 1402, ♀	48.8	42.2	25.8	5.7	20.6	7.9	9.3
WC 1425, ♀	45.0	39.1	24.2	5.7	18.1	7.5	9.8
WC 1444, ♀	42.3	35.9	22.5	5.8	16.8	7.2	8.9
Neotoma cinerea orolestes, northern Gunnison County							
Mean, 5 ♂	49.50	42.88	25.78	5.96	19.64	7.82	10.06
Minimum	47.4	40.6	24.7	5.4	18.7	7.4	9.7
Maximum	52.5	46.5	28.0	6.5	20.2	8.2	10.6
WC 1112, ♀	49.3	42.6	25.9	5.9	20.4	8.1	10.4
KU 29209, ♀	48.4	41.7	25.3	5.8	20.4	7.6	10.0
Neotoma cinerea rupicola, 21 mi. N, 5 mi. E Stoneham, Weld County							
KU 37147, ♂	48.0	41.3	24.9	5.8	19.9	7.9	10.3
KU 37145, ♀	48.5	41.4	25.6	5.7	20.3	8.1	10.8
2 mi. S, 17 mi. W Peetz, Logan County							
KU 69607, ♀	46.4	39.7	24.8	6.0	19.2	7.6	9.3
KU 69609, ♀	48.2	41.4	25.8	5.9	19.9	7.8	9.7

Neotoma micropus

Gray Woodrat

Neotoma micropus occurs in the southern Great Plains and adjacent areas, from northeastern Mexico northward to southeastern Colorado and southern Kansas. Typical habitat of the species in Colorado is open areas, in communities dominated by short-grasses and *Opuntia arborescens*. The presence of arborescent cactus, commonly called "cholla," seems to allow survival of *N. micropus* in southeastern Colorado in an area of otherwise marginal habitat. Dens typically are built at the base of cactus, and are constructed mostly of joints of *O. arborescens*. For details of the natural history of *N. micropus* in Colorado, see Finley (1958:486). Birney (1970) presented a thorough biosystematic study of *N. micropus* throughout its range, and assessed relationships with *N. floridana* and *N. angustipalata*.

Neotoma micropus canescens J. A. Allen

Neotoma micropus canescens J. A. Allen, Bull. Amer. Mus. Nat. Hist., 3:285, 30 June 1891; type locality, North Beaver Creek [North Canadian River], Cimarron Co., Oklahoma.

Distribution in Colorado.—Southeastern corner of state, generally south of the Arkansas River, westward to south-central Las Animas County (Fig. 75).

Comparison.—From *N. m. micropus*, the subspecies geographically adjacent to the east, *N. m. canescens* differs in smaller average size and paler color.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of four females, all from Las Animas and Baca counties, are: 353.0 (338-361), 325.0 (318-332); 139.5 (131-149), 133.5 (130-138); 39.2 (36-42), 36.5 (34-40); a male weighed 294.6, three females, 201, 187, 180. For cranial measurements, see table 21.

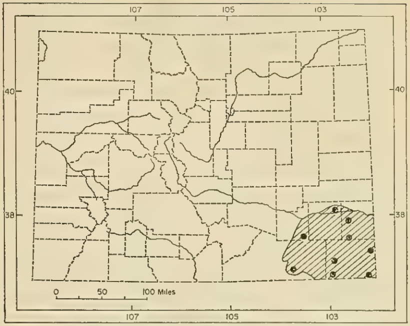


FIG. 75. Distribution of *Neotoma micropus canescens* in Colorado. For explanation of symbols, see p. 9.

Remarks.—Finley (1958:310) recorded the gray wood rat only from south of the Arkansas River in Colorado. In July 1969, specimens of *N. micropus* were captured at a place 2 mi. S and 2 mi. E Hasty, Bent County, a locality about one-half mile north of the Arkansas River. The rats were captured at dens constructed primarily of sticks and situated in sandstone ledges, although houses built of cactus joints, more typical of *N. micropus*, were observed nearby. The locality in question is about one mile northeast of Caddoa Dam, which impounds the Arkansas River in John Martin Reservoir. Whether the gray woodrat occurred north of the Arkansas prior to damming of the river is not known. The immediate valley of the Arkansas River in the vicinity of Hasty is greatly disturbed, and the vegetation consists largely of the exotic shrub *Tamarix gallica*, salt-cedar. Woodrats were encountered only on a bench above the flood plain, and there was no indication of widespread disturbance on the bench. The eastern woodrat, *Neotoma floridana*, is not known from this locality.

Finley (1958:314) discussed in detail the wide variability of gray woodrats from some Coloradan localities. The variability was ascribed to hybridization between *N. m. canescens* and *N. albigula warreni*. For comments on such hybridization, see the account of *N. albigula*.

Records of occurrence.—Specimens examined, 64, distributed as follows: OTERO COUNTY: JJ Ranch, 18 mi. S La Junta, 1 (USNM). BENT COUNTY: 2 mi. S, 2 mi. E Hasty, 10 (KU). PROWERS COUNTY: 15 mi. S Lamar, 1 (CSU); 1 mi. N Two Buttes Reservoir, 4350 ft., 1 (KU). LAS ANIMAS COUNTY: 11 mi. N, 8 mi. E Branson, 5600 ft., 4 (KU). BACA COUNTY: *Two Buttes Reservoir*, 1 (DMNH); *16 mi. N, 1 mi. E Springfield*, 2 (KU); Monon, 7 (WC); 5 mi. S, 2 mi. W

Pritchett, 20 (KU); 2 mi. N, 7 mi. W Regnier, 4550 ft., 4 (KU); *Furnace [Furnish] Canyon,* 10 (DMNH); Craugh Ranch, Cimarron River, 3 (DMNH).

Neotoma albigula

WHITE-THROATED WOODRAT

Neotoma albigula ranges widely in southwestern United States and northern Mexico. In Colorado, the species is confined to southeastern and southwestern parts of the state, where individuals occur at elevations up to about 7000 feet under suitable conditions. Species of *Opuntia* are important as food and construction material. Dens may be constructed under rock shelters or in more open areas at the base of a shrub or cactus. Details of the natural history of *N. albigula* in Colorado were presented by Finley (1958).

Three species of *Neotoma* occur sympatrically in parts of southeastern Colorado. Preferred habitat of *Neotoma mexicana* includes horizontal rock shelters as den sites. *Neotoma albigula* and *N. micropus,* on the other hand, are woodrats of more open country. Where *albigula* and *micropus* occur together, the former species usually utilizes rock shelters, and the latter typically constructs houses in more open situations. Where these two species are not in competition, their denning habits are very similar (see Finley, 1958:527).

In southwestern Colorado, *N. albigula* is sympatric with *N. mexicana* and *N. cinerea.* Habitat segregation is better developed among the woodrats of that area than among those in the southeast. *N. albigula* occupies the lowest, most arid sites and constructs houses mostly of cactus joints. *Neotoma mexicana* occurs at moderate elevations in the foothills and lower mountains and shows a predilection for horizontal rock shelters. *Neotoma cinerea* occurs at moderate to high elevations in the mountains and prefers vertical fissures, "chimneys," and caves as shelter.

Neotoma albigula brevicauda Durrant

Neotoma albigula brevicauda Durrant, Jour. Mamm., 15:65, 16 February 1934; type locality, Castle Valley, 15 mi. NE Moab, Grand Co., Utah.

Distribution in Colorado.—At lower elevations in Dolores-San Miguel drainage (Fig. 76).

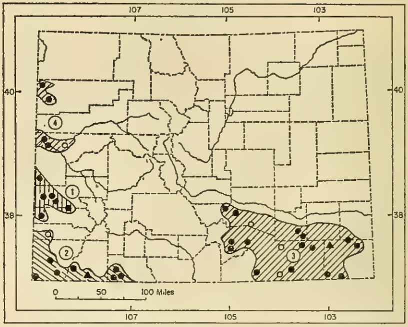


FIG. 76. Distribution of two species of woodrats in Colorado. 1. *Neotoma albigula brevicauda.* 2. *N. a. laplataensis.* 3. *N. a. warreni.* 4. *Neotoma lepida sanrafaeli.* For explanation of symbols, see p. 9.

Comparisons.—From *N. a. laplataensis,* the subspecies of the San Juan drainage to the south, and from *N. a. warreni,* the subspecies of southeastern Colorado, *N. a. brevicauda* differs in having a heavier rostrum, square squamosal roots of zygomatic arches, posteriorly broader incisive foramina, and broader upper incisors (after Finley, 1958: 292).

Measurements.—External measurements of a male and three females from 1 mi. SW of Gateway, Mesa County, are: 339, 334, 307, 318; 148, 150, 139, 131; 34, 35, 33, 34; 29, 28, 29, 28; weights, 169, 166, 146, 160. Selected cranial measurements are presented in table 21.

Records of occurrence.—Specimens examined, 15, distributed as follows: MESA COUNTY: 1 mi. SW Gateway, 4600 ft., 8 (KU). MONTROSE COUNTY: 4 mi. SE Uravan, 1 (UMMZ); Bedrock, 5150 ft., 4 (1 AMNH, 3 WC); 1 mi. NE Naturita, 5900 ft., 1 (KU); Coventry, 6800 ft., 1 (AMNH).

Additional records: Slick Rock, 8 mi. N, 3 mi. E Egnar, 5800 ft. (den record, Finley, 1958:293).

Neotoma albigula laplataensis F. W. Miller

Neotoma albigula laplataensis F. W. Miller, Proc. Colorado Mus. Nat. Hist., 12:2, 22 July 1933; type locality, Bondad, La Plata Co., Colorado.

Distribution in Colorado.—At lower elevations in drainage of San Juan River (Fig. 76).

Comparisons.—For comparison with other

Coloradan subspecies, see accounts of those taxa.

Measurements.—External measurements of three females from La Plata County are: 326, 307, 314; 150, 135, 138; 36, 36, 34; 29, 30, 28; weights, 161, 181, 150. Selected cranial measurements are presented in table 21.

Records of occurrence.—Specimens examined, 19, distributed as follows: MONTEZUMA COUNTY: 2 mi. S, 4 mi. W Cortez, 5900 ft., 1 (KU); *Wetherill Mesa, Mesa Verde National Park,* 1 (KU); *Chapin Mesa, Mesa Verde National Park,* 1 (KU); 17 mi. S, 6 mi. E Cortez, 5600 ft., 3 (KU); Four Corners, 3 (DMNH). LA PLATA COUNTY: 15 mi. S, 5 mi. E Mancos, 6500 ft., 3 (KU); *2 mi. NE Bondad, 6100 ft.,* 2 (KU); Bondad, 6050 ft., 3 (1 DMNH, 2 KU). ARCHULETA COUNTY: Stollsteimer Creek, near mouth of Deep Cañon, 1 (UNM); 1 mi. N Juanita, 1 (UNM); SE 1/4, NE 1/4 sec. 18, T. 32 N, R. 4 W, 1 (UNM).

Additional records (den records, Finley, 1958: 297): DOLORES COUNTY: 1 mi. N Cahone, 6900 ft. ARCHULETA COUNTY: *Arboles.*

Neotoma albigula warreni Merriam

Neotoma albigula warreni Merriam, Proc. Biol. Soc. Washington, 21:143, 9 June 1908; type locality, Gaume's Ranch [sec. 21, T. 28 S, R. 50 W], 4600 ft., Baca Co., Colorado.

Distribution in Colorado.—At lower elevations in southeastern part of state, south of Arkansas River and east of mountain front (Fig. 76).

Comparisons.—From both *N. a. brevicauda* and *N. a. laplataensis,* subspecies of western Colorado, *N. a. warreni* differs in having more angular temporal ridges, narrower maxillovomerine notch, deeper anterointernal fold on M1, and generally grayer color (in some specimens approaching that of *N. micropus*).

Measurements.—Mean (and extreme) external measurements of seven males, followed by those of 10 females, from Otero, Prowers, and Baca counties, are: 332.9 (314-354), 321.3 (303-339); 137.0 (126-147), 134.2 (129-147); 35.9 (33-37), 35.8 (35-37); 27.6 (26-29), 27.3 (26-30); weights, 236.3 (188-279), 201.1 (146-271). Selected cranial measurements are presented in table 21.

Remarks.—Finley (1958:308) listed as additional records of occurrence of *N. albigula* the localities of Badito and Walsenburg, which were noted by Cary (1911:118) in his account of *N.* [*mexicana*] *fallax.* Finley judged the records (apparently never substantiated by specimens) to represent *N. albigula,* because Cary (*loc. cit.*) had described the dens as being constructed entirely of joints of tree cactus. Inasmuch as Finley found no house of *N. mexicana* built of cactus, he concluded that Cary's observation must have been of dens of *albigula.*

Cliffs along the north side of Lathrop Reservoir, 1 mi. S and 2 mi. W of Walsenburg, support vegetation of juniper and broadleafed shrubs (particularly chokecherry, *Prunus virginiana*); *Opuntia arborescens* also is abundant. Dens of *Neotoma* were built along these cliffs in horizontal cracks behind prostrate junipers and contained a high proportion of cactus joints. In August 1969, traps were set along these cliffs and immature woodrats of two species, *N. albigula* and *N. mexicana,* were obtained. The specimen of *N. albigula* was trapped at a den built of cactus joints and sticks. The Mexican woodrat was captured a few feet from the rimrock in a stand of piñon-juniper woodland and was not associated with a den. All dens encountered in the area contained some cactus joints. Because of the documented sympatry of *N. albigula* and *N. mexicana* west of Walsenburg, and the possibility that dens of cactus joints may be used or built in that vicinity by *N. mexicana,* I hesitate to admit the den record of Cary (*loc. cit.*), or its reinterpretation by Finley (*loc. cit.*).

Rapp (1962) reported fleas from a woodrat captured in Crowley County and identified as *N. a. warreni.* On the basis of geographic considerations, I suspect that the record, in fact, represents *N. floridana.*

Finley (1958:299-308) discussed the remarkable variability of *N. albigula* and *N. micropus* from southeastern Colorado. In particular, some specimens were noted to exhibit intermediacy between the two species, or a combination of characters typical of *albigula* or *micropus.* The intermediacy was attributed by Finley (*op. cit.*:306) to occasional local hybridization. Localities from which supposed hybrids were examined are: vicinity of Two Buttes Reservoir, Prowers and Baca counties, Gaume's Ranch and Monon, Baca County, and the vicinity of Higbee, Otero

County. In southern Baca County (Furnish Canyon, Regnier), evidence of hybridization, while present, is slight. That hybridization and not intergradation is responsible for observed variation is supported by the sympatry of the two species at some localities (for example, Furnish Canyon, Regnier) with little evidence of genetic communication and the occurrence (at Two Buttes Reservoir) of individuals clearly referable to one or the other species as well as apparent hybrids (after Finley, *op. cit.*:307, which see for alternative explanations).

Records of occurrence.—Specimens examined, 80, distributed as follows: CUSTER COUNTY: 2 mi. E Wetmore, 5700 ft., 1 (KU). PUEBLO COUNTY: near Rock Creek Hill, along Colorado Highway 76, 1 (SCSC). HUERFANO COUNTY: 20 mi. E Walsenburg, 1 (DMNH); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 1 (KU); 9 mi. SW Walsenburg, 6600 ft., 3 (KU). OTERO COUNTY: 6 mi. NW Higbee, 4550 ft., 2 (KU); *JJ Ranch, Higbee, 18 mi. S La Junta,* 1 (USNM); 1 mi. NW Higbee, 4200 ft., 12 (KU). PROWERS COUNTY: Two Buttes Peak, 4500 ft., 4 (KU); *1 mi. N Two Buttes Reservoir, 4350 ft.,* 1 (KU). LAS ANIMAS COUNTY: *Rock Crossing, 30 mi. S La Junta,* 1 (DMNH); 10 mi. N Officer, 1 (DMNH); Irwin's Ranch [T. 29 S, R. 52 W], 2 (WC); 11 mi. N, 8 mi. E Branson, 5600 ft., 1 (KU); 1 mi. S, 7 mi. E Trinidad, 3 (KU); *Cook Ranch, Hillside Spring* (not found), 1 (CSU). BACA COUNTY: *Two Buttes Reservoir, 4350 ft.,* 6 (2 DMNH, 4 KU); Gaume's Ranch, 4600 ft., 10 (1 USNM, 9 WC); Two Buttes, 1 (DMNH); *Furnace [Furnish] Canyon,* 1 (DMNH); *Jimmie Creek,* 4 (DMNH); 2 mi. N, 7 mi. W Regnier, 4550 ft., 6 (KU); *2 mi. N Regnier, 4575 ft.,* 10 (KU); Regnier, 4500 ft., 6 (1 DMNH, 5 KU).

Additional records: PUEBLO COUNTY: near junction Huerfano and Cucharas rivers (F. W. Miller, 1931c:432). LAS ANIMAS COUNTY: 9 mi. W junction Purgatoire River and Chaquaqua [Chacuacho] Creek (Finley, 1958:308); Trinchera (F. W. Miller, 1931c:432). BACA COUNTY: *Two Buttes Creek, 14 mi. N Springfield, 4300 ft.* (Finley, 1958: 308).

Neotoma lepida

Desert Woodrat

Neotoma lepida is a mammal of the Great Basin and adjacent deserts, reaching the eastern limit of its range in extreme western Colorado. Desert woodrats commonly den under cover of rocks in shrub communities or piñon-juniper woodlands. The highest elevation from which specimens were examined is 6200 feet on Douglas Creek, south of Rangely. For details of the natural history of the desert woodrat in Colorado, see Finley (1958:514). Warren (1926a) presented notes on reproduction.

Neotoma lepida is readily distinguished from other kinds of woodrats known to occur in Colorado by its small size and truncate anterior palatine spine.

Neotoma lepida sanrafaeli Kelson

Neotoma lepida sanrafaeli Kelson, Jour. Washington Acad. Sci., 39:418, 9 January 1950; type locality, Rock Canyon Corral, 5 mi. SE Valley City, 4500 ft., Grand Co., Utah.

Distribution in Colorado.—Known only from lower elevations in White and Colorado watersheds, north and south of Roan Plateau (Fig. 76).

Comparison.—From *N. l. monstrabilis,* the subspecies of south-central Utah, *N. l. sanrafaeli* differs in generally paler dorsal color, and larger, more angular skull (Durrant, 1952: 342).

Measurements.—External measurements of three males, followed by mean (and extremes) of six females from northwestern Mesa County are: 294, 289, 290, 274.8 (266-287); 120, 126, 112, 114.0 (110-122); 31, 32, 33, 31.7 (31-32); 30, 29, 37, 29.5 (28-31); weights of two males, 136, 108, of four females, 110, 111, 104, 104. Selected cranial measurements are presented in table 21.

Remarks.—Finley (1958:332) expressed the expectation that *N. lepida* eventually will be found to be more widespread in northwestern Colorado than presently is documented, perhaps occurring farther east in the White and Colorado River valleys, and also on the Yampa Plateau.

Records of occurrence.—Specimens examined, 21, distributed as follows: RIO BLANCO COUNTY: 5 mi. W Rangely, 5600 ft., 4 (USNM); 18 mi. S, 2 mi. E Rangely, 6200 ft., 2 (KU); Douglas Creek, 19 mi. S Rangely, 1 (CM). MESA COUNTY: Mack, 6 (WC); 1 mi. SW Mack, 4600 ft., 6 (KU); 1 1/2 mi. S Loma, 4600 ft., 2 (KU).

Additional record: MESA COUNTY: foot of Book Cliffs, 5 mi. W Palisade (Finley, 1958:332).

Neotoma mexicana

Mexican Woodrat

The Mexican woodrat has a broad distribution in the southwestern United States and

Mexico. The northern limits of the species are in Colorado—in Larimer County on the Eastern Slope and in Mesa County on the Western Slope. Known altitudinal range of *Neotoma mexicana* in Colorado is from about 4300 feet in the Purgatoire drainage of Otero County to about 8300 feet near Poncha Pass. Favored habitat in western and southeastern Colorado is piñon-juniper woodlands. Farther north on the Eastern Slope, rocky sites with plant communities dominated by scrub oak or mountain mahogany are occupied.

For detailed observations on the natural history of *N. mexicana* in Colorado, see Finley (1958:408). Notes on reproduction were presented by Warren (1926a) and L. N. Brown (1969) reported a detailed study of reproduction in Mexican woodrats near the northern limit of the range in Larimer County. For comments on the karyotype of Coloradan Mexican woodrats, see Milek and Huizinga (1968).

Neotoma mexicana fallax Merriam

Neotoma fallax Merriam, Proc. Biol. Soc. Washington, 9:123, 2 July 1894; type locality, Gold Hill, Boulder Co., Colorado.

Neotoma mexicana fallax, Goldman, N. Amer. Fauna, 31:56, 19 October 1910.

Distribution in Colorado.—Foothills of Front Range; west in Arkansas Valley to vicinity of Salida, east on Platte-Arkansas Divide to vicinity of Peyton (Fig. 77).

Comparisons.—From *N. m. scopulorum*, the subspecies to the south and east in Colorado, *N. m. fallax* differs in having somewhat darker, grayer pelage (more heavily overlaid with black), and a smaller, less angular skull with narrower upper incisors, larger molars, longer and less rectangular interparietal, and narrower nasals. From *N. m. inopinata*, the subspecies of southwestern Colorado and adjacent areas, *N. m. fallax* differs in having somewhat grayer pelage, paler colored and broader upper incisors, and greater average zygomatic breadth. For more detailed comparisons, see Finley (1958:276).

Measurements.—Mean (and extreme) external measurements of eight males, followed by those of six males, from Larimer and Boulder counties, are: 337.9 (313-361), 321.4 (303-334); 153.8 (144-167), 141.7 (132-150); 34.2 (33-36), 32.0 (30-34); a male weighed 149.0. Selected cranial measurements are presented in table 21.

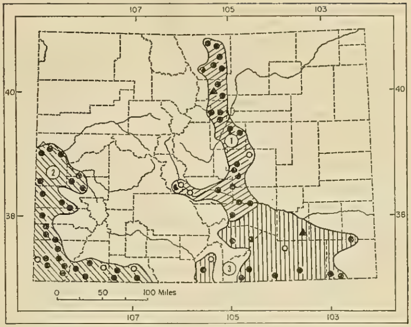


FIG. 77. Distribution of *Neotoma mexicana* in Colorado. 1. *N. m. fallax*. 2. *N. m. inopinata*. 3. *N. m. scopulorum*. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 192, distributed as follows: LARIMER COUNTY: 21 mi. NW Fort Collins, 1 (CU); *17 mi. NW Fort Collins*, 1 (CU); 1 mi. N Owl Canyon, 1 (CSU); *Owl Canyon*, 1 (CSU); *14 mi. NW Fort Collins*, 1 (USNM); *6 mi. N, 8 1/2 mi. W Fort Collins*, 1 (CSU); *Ted's Place*, 1 (CU); *8 mi. NW Fort Collins*, 1 (CSU); *7 mi. NW Fort Collins*, 3 (CU); *5 1/2 mi. NW Fort Collins*, 3 (CSU); *Bingham Hill*, 7 (6 CSU, 1 CU); *5 mi. W Fort Collins*, 3 (1 CSU, 2 CU); *4 mi. W Fort Collins*, 1 (CSU); 2 mi. W Fort Collins, 1 (CU); *2 mi. S, 3 mi. W Fort Collins*, 2 (CU); *Horsetooth Reservoir*, 1 (CU); *2 1/2 mi. S, 3 mi. W Fort Collins*, 1 (CU); *4 mi. SW Fort Collins*, 2 (1 CSU, 1 CU); *Dixon Dam*, 1 (CU); *3 mi. S, 2 mi. W Fort Collins*, 1 (CU); *3 mi. S, 3 mi. W Fort Collins*, 1 (CU); *5 mi. SW Fort Collins*, 5 (1 CSU, 4 UI); *6 mi. SW Fort Collins*, 2 (1 CSU, 1 CU); *Spring Canyon Dam*, 10 (2 CSU, 8 CU); *7 mi. SW Fort Collins*, 1 (CSU); *1/4 mi. S Spring Canyon Dam*, 1 (CSU); *8 mi. SW Fort Collins*, 1 (CSU); *Spring Canyon, 5400 ft.*, 1 (CSU); *1/2 mi. S Horsetooth Reservoir*, 1 (CU); *1 mi. W Masonville*, 1 (CSU); *3 mi. S Spring Canyon Dam*, 1 (CU); *sec. 22, T. 6 N, R. 70 W*, 1 (CU); *Arkins, 5400 ft.*, 2 (USNM); 15 mi. SW Fort Collins, 1 (CU); *6 1/2 mi. W Loveland*, 1 (CU); *3 1/2 mi. W Loveland, 5030 ft.*, 1 (KU); Loveland, 16 (USNM); Estes Park, 1 (AMNH); *no locality other than county*, 1 (CSU). BOULDER COUNTY: Lyons, 1 (FMNH); *10 4/10 mi. NW Boulder*, 1 (CU); Gold Hill, 21 (USNM); *1 mi. S, 2 mi. E Gold Hill, 7100 ft.*, 1 (KU); Boulder, 13 (2 CU, 7 FMNH, 4 USNM); *near Boulder*, 1 (CU); *Skunk Canyon, S of Boulder*, 2 (CU); *base of Flag-*

staff Mountain, 1 (CU); *Boulder Canyon,* 1 (CU); *Gregory Canyon,* 1 (CU); *Bluebell Canyon,* 1 (CU); *no locality other than county,* 4 (1 DMNH, 3 USNM). JEFFERSON COUNTY: *1 1/2 mi. NW Golden, 6200 ft.,* 1 (KU); Forks Creek, 4 (CU); South Table Mountain, near Golden, 3 (DMNH); *Green Mountain, 4 mi. W Denver, 5500 ft.,* 1 (CSC); Morrison, 4 (CU). DOUGLAS COUNTY: Daniel's Park, 7 mi. N, 4 mi. W Castle Rock, 6400 ft., 5 (KU); Franktown, 1 (DMNH). CHAFFEE COUNTY: 7 mi. SW Salida, 8300 ft., 1 (KU). EL PASO COUNTY: 3 mi. N Colorado Springs, 3 (AMNH); *Colorado Springs,* 1 (MCZ); 3 mi. SW Colorado Springs, 1 (UMMZ); *5 mi. SW Colorado Springs,* 1 (UMMZ); *4 mi. S main gate, Camp Carson,* 1 (KU); 10 mi. S Colorado Springs, 8 (UMMZ). FREMONT COUNTY: *18 mi. S, 7 mi. W Colorado Springs,* 2 (KU); 4 1/2 mi. NE Penrose, 5 (UI); *Garden Park, 6 mi. up Red Cañon, N of Cañon City,* 1 (DMNH); *2 mi. NW Cañon City,* 1 (DMNH); Cañon City, 5 (USNM). PUEBLO COUNTY: Swallows, 5000 ft., 1 (SCSC); *1 mi. N Pueblo,* 3 (SCSC); *Fountain Creek at Overton Road,* 2 (SCSC); *12 mi. W Pueblo,* 2 (SCSC); *11 mi. W Pueblo,* 1 (SCSC); *2 6/10 mi. W Pueblo,* 1 (SCSC); Pueblo, 1 (SCSC); Buelah, 1 (SCSC).

Additional records (Finley, 1958:278, unless otherwise noted): BOULDER COUNTY: *Salina; 5 mi. S Gold Hill; Blanchard Ranch, 5 mi. W Boulder; Boulder Creek* (Elliot, 1907:272); *Bear Canyon, 3 mi. S Boulder.* CHAFFEE COUNTY: *Salida, 7300 ft.* EL PASO COUNTY: 3 mi. N, 2 mi. W Peyton, 7400 ft. (den record); *Van Andert's Spring, Little Fountain Creek, 6200 ft.* PUEBLO COUNTY: *Arkansas River, 1 mi. below Swallows.*

Neotoma mexicana inopinata Goldman

Neotoma mexicana inopinata Goldman, Jour. Washington Acad. Sci., 23:471, 15 October 1933; type locality, Chuska Mountains, 8800 ft., San Juan Co., New Mexico.

Distribution in Colorado.—Foothills, plateaus and mesas of southwestern part of state, south of Colorado and Gunnison rivers (Fig. 77).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa.

Measurements.—Mean (and extreme) external measurements of eight males, followed by those of six females, from Mesa and Montrose counties, are: 325.0 (297-358), 321.7 (298-342); 145.0 (124-169), 143.0 (132-152); 33.2 (29-35), 33.7 (32-37); —, 26.5 (26-28). Two males weighed 191, 194; mean weight of four females, 171.75 (153-202). External measurements of two males and mean (and extremes) of six females from La Plata and Archuleta counties are: 338, 338, 329.0 (322-336); 129, 156, 149.8 (144-157); 34, 36, 35.2 (34-36); 27, 28, 27.3 (26-29); weights, 168, 173, 167.5 (151-191). For selected cranial measurements, see table 21.

Records of occurrence.—Specimens examined, 75, distributed as follows: MESA COUNTY: 2 1/2 mi. S Fruita, 4600 ft., 1 (KU); *Fruita Cañon, Colorado National Monument,* 2 (CU); Sieber Ranch, Little Dolores Creek, 1 (WC); *1/4 mi. E Grandview, Colorado National Monument,* 1 (CNM); Grand Junction, 2 (1 FMNH, 1 MCZ); 1 mi. SW Gateway, 4600 ft., 4 (KU); *2 1/2 mi. S, 1 mi. W Gateway, 5500 ft.,* 1 (KU). DELTA COUNTY: 8 mi. [N]W Olathe, 4 (DMNH). MONTROSE COUNTY: 17 mi. SW Delta, 2 (DMNH); 7 1/2 mi. W Montrose, 6000 ft., 3 (KU); 2 mi. E Paradox, 1 (DMNH); 1 mi. E Naturita, 5900 ft., 6 (KU); Coventry, 6800 ft., 3 (1 AMNH, 2 USNM). SAN MIGUEL COUNTY: 8 mi. N, 3 mi. E Egnar, 5800 ft., 2 (KU). DOLORES COUNTY: 1 mi. N Cahone, 6900 ft., 3 (KU); *2 mi. S, 4 mi. W Cahone, 7000 ft.,* 4 (KU); 2 mi. S, 6 1/2 mi. E Cahone, 6800 ft., 1 (KU). MONTEZUMA COUNTY: 1 mi. NW Dolores, 7000 ft., 2 (UI); Ashbaugh's Ranch [Moqui], 5350 ft., 2 (1 AMNH, 1 USNM); 5 mi. E Cortez, 6400 ft., 1 (KU); Ute Peak, 3 (DMNH); Mancos River, 6200 ft., Mesa Verde National Park, 1 (KU); *Headquarters, Mesa Verde National Park, 7000 ft.,* 4 (KU); *Spruce Tree Lodge, 6950 ft.,* 2 (KU); 17 mi. S, 6 mi. E Cortez, 6400 ft., 1 (KU). LA PLATA COUNTY: 2 mi. E Durango, 7500 ft., 1 (KU); *1 mi. S, 3 mi. W Durango, 7200 ft.,* 1 (KU); 12 mi. S, 5 mi. E Mancos, 6800 ft., 1 (KU); *2 mi. NE Bondad, 6100 ft.,* 3 (KU); Bondad, 6050 ft., 5 (KU). ARCHULETA COUNTY: Stollsteimer Creek, near mouth of Deep Cañon, 1 (UNM); *Deep Cañon,* 3 (UNM); 1 mi. S, 2 mi. W Chromo, 7200 ft., 1 (KU); Piedra River, NW 1/4 sec. 4, T. 32 N, R. 5 W, 1 (UNM); *NE 1/4, SE 1/4 sec. 18, T. 32 N, R. 4 W,* 1 (UNM).

Additional records (Finley, 1958:288, unless otherwise noted): SAN MIGUEL COUNTY: *Coventry, 6800 ft.;* 8 mi. NE Dove Creek, 7000 ft. MONTEZUMA COUNTY: near McElmo (Cary, 1911:117); *[S of] Cortez.* LA PLATA COUNTY: Bayfield (Cary, 1911:117). ARCHULETA COUNTY: Pagosa Springs (Cary, *loc. cit.*); Arboles (Goldman, 1910:57).

Neotoma mexicana scopulorum Finley

Neotoma mexicana scopulorum Finley, Univ. Kansas Publ., Mus. Nat. Hist., 5:529, 15 August 1953; type locality, 37°47′N, 103°28′W, 3 mi. NW Higbee, 4300 ft., Otero Co., Colorado.

Distribution in Colorado.—Canyons, mesas, escarpments and foothills of southeastern part of state, south of Arkansas River, east to Two Buttes Peak; San Luis Hills (Fig. 77).

Comparisons.—For comparison with *N. m. fallax,* see account of that subspecies. From *N. m. inopinata,* the subspecies of southwestern Colorado, *N. m. scopulorum* differs in having a larger, more arched skull, laterally concave supraorbital ridges, heavier zygomatic arches, larger molars, and paler colored and broader upper incisors (see Finley, 1958:280).

Measurements.—External measurements of two males and two females from Prowers and Otero counties are: 362, 360, 379, 369; 150, 158, 178, 169; 37, 38, 38, 37; 26, 26, 26, 25; weights, 253, 238, 246, 231. Cranial measurements are presented in table 21.

Remarks.—Mexican woodrats of the San Luis Hills probably are isolated from other local populations of the species in Colorado by unsuitable habitat of the Culebra Range. None of the specimens in the series from 3 mi. E of San Acacio in the Warren Collection is fully adult. In color, these specimens obviously resemble *scopulorum* in having a pinkish to yellowish wash on the dorsum and not the prominent dirty yellow wash typical of *fallax.* Melanism in Mexican woodrats from the San Luis Hills was reported by Warren (1913b).

Records of occurrence.—Specimens examined, 40, distributed as follows: HUERFANO COUNTY: 20 mi. E Walsenburg, 1 (DMNH); 1 mi. S, 2 mi. W Walsenburg, 6400 ft., 1 (KU). OTERO COUNTY: 3 mi. NW Higbee, 4300 ft., 4 (KU). PROWERS COUNTY: Two Buttes Peak, 4500 ft., 2 (KU). COSTILLA COUNTY: 3 mi. W San Acacio, 8 (WC). LAS ANIMAS COUNTY: Trinidad, 5 (USNM); *Fisher Peak, about 8000 ft.*, 1 (USNM); Mesa de Maya, 1 (UMMZ); Trinchera, 6 (1 AMNH, 5 DMNH); Long Canyon, near Martinsen, 1 (USNM). BACA COUNTY: *Two Buttes [Peak?]* 3 (DMNH); *Two Buttes Reservoir, 4200 ft.*, 2 (KU); Furnace [Furnish] Canyon, 1 (DMNH); Regnier, 4500 ft., 4 (2 DMNH, 2 KU).

Additional records (Finley, 1958:283): COSTILLA COUNTY: 5 mi. SSE Fort Garland. LAS ANIMAS COUNTY: 9 mi. W junction Purgatoire and Chacuacho creeks.

Neotoma cinerea

Bushy-tailed Woodrat

The bushy-tailed woodrat is a cordilleran mammal, occurring throughout mountainous western North America, from northern Arizona and New Mexico northward to southern Yukon Territory. In Colorado the species is widespread, occurring at elevations below 5000 feet in canyons of the Western Slope, and ranging above timberline under suitable circumstances.

Unlike other Coloradan woodrats, *Neotoma cinerea* prefers vertical cracks, crevices, and "chimneys" as den sites. Natural caves and mine tunnels also are utilized, as are outbuildings and dwellings. In buildings and in natural shelters, shelves are selected over den sites at ground level. There are few abandoned mine buildings in the mountains of Colorado that are not replete with evidence of occupation by bushy-tailed woodrats. Warren (1919) described dens in a shaft-house at Alma, Park County. In occupied buildings, the animals may be pests. According to Cockerell (1890:7), *N. cinerea* was "too common on the Sangre de Cristo Range, where it is very troublesome in houses, making much noise at night, and stealing spoons, bottles, and other attractive objects, which it carries to its nest."

For detailed discussion of the natural history of *N. cinerea* in Colorado, see Finley (1958:354). J. H. Brown (1968) and Brown and Lee (1969) studied differential adaptation to environmental temperatures in bushy-tailed woodrats of western United States.

Neotoma cinerea arizonae Merriam

Neotoma arizonae Merriam, Proc. Biol. Soc. Washington, 8:110, 31 July 1893; type locality, Keam Canyon, Navajo Co., Arizona.

Neotoma cinerea arizonae, Goldman, N. Amer. Fauna, 31:106, 19 October 1910.

Distribution in Colorado.—At lower elevations in canyons and on plateaus and mesas of Western Slope (Fig. 78).

Comparison.—For comparison with *N. c. orolestes*, see account of that subspecies.

Measurements.—External measurements of three males from the vicinity of Grand Junction and of two females from western Moffat County are: 347, 348, 358, 346, 343; 148, 155, 162, 142, 146; 41, 43, 42, 41, 40. Mean (and extreme) measurements of seven females from Montezuma and southern Montrose counties are: 352.3 (333-381), 150.6 (137-160), 41.4 (40-43). Cranial measurements are presented in table 21.

Remarks.—The small, pale-colored race of *N. cinerea* in western Colorado has had a complex taxonomic history. The name *arizonae* first was applied to woodrats from northeastern Arizona by Merriam (1893:110),

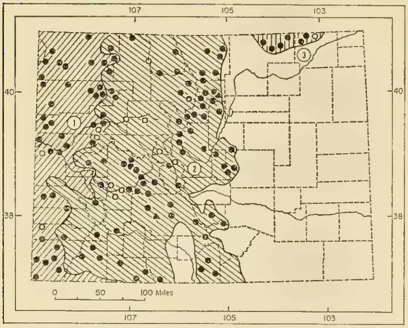


FIG. 78. Distribution of *Neotoma cinerea* in Colorado. 1. *N. c. arizonae*. 2. *N. c. orolestes*. 3. *N. c. rupicola*. For explanation of symbols, see p. 9.

and Warren (1908b:75) referred specimens from southwestern Colorado to that subspecies. J. A. Allen (1895b:331) proposed the name *cinnamomea* for woodrats from southwestern Wyoming, and Warren *(loc. cit.)*, on the advice of Allen, referred specimens from Douglas Spring, near Greystone, Moffat County, to that race. Goldman (1910:104) regarded *cinnamomea* as a synonym of *orolestes*. Warren, (1942:221) maintained his earlier usage of the name *cinnamomea* for bushy-tailed woodrats of northwestern Colorado, commenting: ". . . I have compared my own specimens . . . with a long series of *orolestes* in my collection, and they are a different shade of color from any of these, also smaller . . . , and I prefer to consider this a separate subspecies from *orolestes*, as much different as any of my *arizonae*, although in a somewhat different manner." The nominal race *cinnamomea* was said to differ from *arizonae* in paler color and less bushy tail. Hooper (1944:415) revived the name *cinnamomea* for animals from southwestern Wyoming; no comparison was made with *N. c. arizonae*.

Finley (1958:263) made extensive comparisons of specimens of *N. cinerea* from northwestern and southwestern Colorado and adjacent areas. No consistent differences were found between animals from the two areas. Therefore, Finley (*op. cit.*:260) arranged *cinnamomea* as a synonym of *arizonae*. I have reviewed evidence presented by Finley and have repeated a number of the comparisons. I concur in the opinion that *arizonae* and *cinnamomea* are inseparable and in Colorado form a single, essentially continuous population.

Hall and Kelson (1958:704) referred two specimens from north and west of Rangely to the subspecies *N. c. macrodon*, a race recognized (Kelson, 1949) on the basis of material from the drainage of Willow Creek, Uintah Co., Utah. The range of *macrodon* was supposed by Durrant (1952:351) to be limited to the East Tavaputs Plateau, an upland lying between the Colorado and White rivers and essentially continuous into Colorado as the Roan Plateau. On the basis of geographic considerations, one would expect animals from the Roan Plateau in Colorado to represent *macrodon*. Specimens examined from that area are to me indistinguishable from other Coloradan woodrats herein referred to *N. c. arizonae*; so, too, are those individuals from north and west of Rangely (north of the White River) that were referred to *macrodon* by Hall and Kelson *(loc. cit.)*. I have not had undoubted specimens of *macrodon* from Utah for comparison.

Records of occurrence.—Specimens examined, 124, distributed as follows: MOFFAT COUNTY: [Little] Snake River, 20 mi. W Baggs, Wyoming, 1 (USNM); *Cherokee Crossing, [Little] Snake River, 25 mi. below Baggs*, 3 (AMNH); *Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers]*, 2 (DMNH); Douglas Spring [T. 7 N, R. 100 W], 5 (WC); *2 mi. SE Greystone*, 2 (CM); 8 mi. NE Craig, 1 (CM); *Mantle's Cave, Dinosaur National Monument*, 2 (CU); Castle Park, Dinosaur National Monument, 5200 ft., 2 (CU); *above Castle Park, 5600 ft.*, 2 (CU); Lay, 3 (USNM); 5 mi. W Craig, 1 (CM); Lily, 1 (USNM); *5 mi. NW Cross Mountain* 2 (1 AMNH, 1 CM); *N bank Yampa River, 4 mi. NNW Cross Mountain*, 3 (AMNH); *S bank Yampa River, 4 mi. NNW Cross Mountain*, 4 (1 AMNH, 3 CM); 1 mi. S Cross Mountain, 1 (KU); 11 mi. N, 11 mi. W Rangely, 6000 ft., 1 (KU). RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 1 (USNM); 5 mi. N, 10 mi. W Rangely, 5800 ft., 1 (KU); 6 mi. NE Meeker, 5 (CM); N side White River, 4 mi. W Meeker, 2 (CM); *Meeker*, 1 (USNM); Dry Fork, White River, 6500 ft., 10 (AMNH); *Dry Fork, White River, 6200 ft.*, 2 (AMNH); Grand Hogback, 5 mi. S Meeker, 6 (CM); Douglas Creek, 19 mi. S Rangely, 2 (1 AMNH, 1 CM). GARFIELD COUNTY: Atchee, 6600 ft., 2 (WC); West Fork Douglas Creek, 35 mi. S Rangely, 1 (CM); New Castle, 1 (MCZ); 8 mi. W Rifle, 1 (USNM); 20 mi. N Mack, 4 (CM). MESA COUNTY: 25 mi. N Grand Junction, 1 (CM); 4 mi. S, 3 mi. E Collbran, 6800 ft., 2 (KU); Stateline, 1

(CM); 1 mi. W Cameo, 1 (CU); *1 mi. SW Fruita,* 1 (DMNH); *2 1/2 mi. S Fruita, 4600 ft.,* 1 (KU); Headquarters, Colorado National Monument, 1 (CNM); Grand Junction, 4600 ft., 8 (2 AMNH, 1 FMNH, 3 MCZ, 2 WC). MONTROSE COUNTY: 4 mi. SE Uravan, 1 (UMMZ); Bedrock, 5150 ft., 1 (WC); Coventry, 6800 ft., 2 (1 USNM, 1 WC). DOLORES COUNTY: *2 mi. S, 4 mi. W Cahone, 7000 ft.,* 7 (KU); 2 mi. S, 3 mi. W Cahone, 7000 ft., 1 (KU). MONTEZUMA COUNTY: 1 1/2 mi. W Dolores, 7000 ft., 1 (KU); S of Cortez, 4 (WC); *2 mi. S, 24 mi. W Cortez, 4850 ft.,* 2 (KU); 1 mi. S, 22 mi. W Cortez, 5000 ft., 1 (KU); *Ashbaugh's Ranch [Moqui], 5350 ft.,* 4 (2 USNM, 2 WC); *5 mi. S Cortez,* 2 (CM); Ute Peak, 1 (DMNH); Spruce Tree House, Mesa Verde National Park, 1 (DMNH); Four Corners, 4 (DMNH).

Additional records (Finley, 1958:270, unless otherwise noted): MOFFAT COUNTY: *Escalante Hills* (Warren, 1942:221). RIO BLANCO COUNTY: *5 mi. W Rangely.* GARFIELD COUNTY: 12 mi. SE Rifle. MESA COUNTY (P. H. Miller, 1964:73): *West Entrance, Colorado National Monument, 4700 ft.; 1/2 mi. W Distant View, Rim Rock Drive, 5680 ft.; head North Monument Canyon, 5780 ft.; Monument Mesa, 2 3/10 mi. E Rim Rock Drive, 6500 ft.;* Sieber Ranch, Little Dolores River. DOLORES COUNTY: canyon 8 mi. above Dove Creek.

Neotoma cinerea orolestes Merriam

Neotoma orolestes Merriam, Proc. Biol. Soc. Washington, 9:128, 2 July 1894; type locality, Saguache Valley, 20 mi. W Saguache, Saguache Co., Colorado.

Neotoma cinerea orolestes, Goldman, N. Amer. Fauna, 31:104, 19 October 1910.

Distribution in Colorado.—Mountains of central part of state (Fig. 78).

Comparisons—From *N. c. arizonae* and *N. c. rupicola,* subspecies of western and northeastern Colorado, respectively, *N. c. orolestes* differs in richer (typically more reddish and less buffy) color, more heavily overlaid with black, in generally larger size, and in cranial details, notably the presence of narrow elongate bullae.

Measurements.—Mean (and extreme) external measurements of five males and measurements of two females, all from northern Gunnison County, are: 391.8 (373-420), 386, 386; 163.8 (146-176), 166, 161; 44.8 (43-46), 43, 43; a female weighed 299. Cranial measurements are presented in table 21.

Remarks.—Bushy-tailed woodrats of central Colorado are highly variable in color, but generally homogeneous in size and cranial detail. Pinkish to reddish colors are typical in animals from the Front Range, Sawatch Range, and Elk Mountains. To the west, paler, buffy pelage is more prevalent. This is taken to indicate intergradation with *N. c. arizonae.* Such intergradation occurs widely at moderate elevations on the Western Slope, and was detailed by Finley (1958:263).

Records of occurrence.—Specimens examined, 261, distributed as follows: MOFFAT COUNTY: 16 mi. N Craig, 6600 ft., 5 (KU); 16 mi. S Craig, 1 (CSU). ROUTT COUNTY: Three Forks, 30 mi. above Bagg's Crossing, 2 (AMNH); *Elk [Elkhead?] Mountains,* 1 (USNM); *no locality other than county,* 1 (DMNH). JACKSON COUNTY: Medicine Bow Range, North Park, 1 (DMNH); 2 mi. N Willow Creek Pass, 2 (UNM). LARIMER COUNTY: 13 mi. N Fort Collins, 1 (CSU); *Owl Canyon,* 1 (CSU); 1 mi. below Columbine Lodge, Poudre Canyon, 1 (FHSC); Poudre Canyon, 25 mi. NW Fort Collins, 6700 ft., 1 (CSU); Watson Lake, 1 (CSU); *sec. 25, T. 8 N, R. 70 W,* 1 (CSU); 7 mi. S Poudre River, 5600 ft., 1 (CSU); *Devil's Gulch,* 1 (CSU); Estes Park, 10 (1 AMNH, 9 USNM); *Moraine Park,* 7 (RMNP); *Rocky Mountain National Park,* 1 (RMNP); *2 1/2 mi. SW Estes Park,* 1 (KU); *Pinewood,* 1 (AMNH); Longs Peak, 1 (USNM); *no locality other than county,* 1 (DMNH). RIO BLANCO COUNTY: Lost Creek, 9 mi. NE Buford, 3 (CM); *Marvine Mountains,* 1 (USNM); South Fork Campground, White River National Forest, 1 (CSU); *Compass Creek* (not found), 1 (AMNH). GARFIELD COUNTY: East Fork Rifle Creek, 20 mi. NE Rifle, 2 (DMNH); Middle Mamm Creek, near Rifle, 2 (DMNH). GRAND COUNTY: near Sheephorn Pass, 4 (WC); Grand Lake, 4 (2 DMNH, 2 WC); Hot Sulphur Springs, 4 (WC). SUMMIT COUNTY: *Gray's Peak,* 2 (KU); Dillon, 2 (UI); Hoosier Pass, 1 (DMNH). BOULDER COUNTY: *foot of Mount Meeker, 8700 ft.,* 4 (AMNH); *Meeker Park Lodge,* 1 (RMNP); *12 1/2 mi. S Estes Park,* 1 (KU); Gold Hill, 9 (3 CU, 6 USNM); 1/2 mi. SW Sunset, 1 (CU); *6 mi. NW Nederland, 9500 ft.,* 1 (CSU); *Science Lodge,* 1 (CU); *3 mi. S Ward, 9000 ft.,* 3 (KU); *Silver Lake Mine, 10,000 ft.,* 1 (USNM); 3 mi. S, 1/2 mi. E Ward, 9400 ft., 7 (KU); *4 mi. N, 1 mi. W Nederland,* 1 (CU); *3 mi. NE Nederland, 8700 ft.,* 1 (KU); Boulder, 9 (FMNH); *Marchioness Tunnel, Boulder Canyon,* 1 (CU); *Boulder Canyon, 8 mi. WSW Boulder, 7500 ft.,* 2 (KU); *S of Boulder,* 1 (CU); *Green Mountain, near Boulder,* 1 (CU); 1 mi. W Hessie, 9200 ft., 1 (CU); *Lake Eldora,* 1 (CU); 3 mi. E Pinecliff, 2 (DMNH); *no locality other than county,* 10 (USNM). GILPIN COUNTY: *SW of Rollinsville, 8800 ft.,* 1 (CU); *S of Rollinsville,* 1 (CU); 3 mi. NW Blackhawk, 1 (UMMZ). CLEAR CREEK COUNTY: Silverplume, 3 (1 FWS, 2 SC); Loveland Pass, 1 (FWS); 4 mi. S Idaho Springs, 1 (CSC); *7 mi. SW Idaho Springs,* 2 (UMMZ); *7 4/10 mi. SW Idaho Springs,* 1 (UMMZ). JEFFERSON COUNTY: Green Mountain, 5 mi. W Denver, 1 (CU); *[near] Denver,* 1 (DMNH). PARK COUNTY: Jefferson, 2 (DMNH); *Montgomery,* 1 (MCZ); *Buckskin Creek,* *1 mi. above Alma,* 1 (WC); *Alma,* 1 (DMNH); Williams Ranch, Fairplay, 1 (DMNH); Tarryall Creek, 8700 ft., 1 (WC); Trout Creek Ranch, Garo, 9500 ft., 1 (USNM). DELTA COUNTY: 1 mi. NE Bowie, 6300 ft., 2 (KU); [above] Cedaredge, 3 (FMNH). GUNNISON COUNTY: Sylvanite Mine, near Gothic, 12,000 ft., 3 (ANSP); Irwin, 1 (AMNH); Crested Butte, 3 (1 AMNH, 1 MCZ, 1 WC); 2 mi. S, 9 mi. E Crested Butte, 9400 ft., 2 (KU); *3 mi. S, 6 1/2 mi. E Crested Butte, 9200 ft.,* 7 (KU); *3 mi. N Almont, 8300 ft.,* 9 (KU); *sec. 36, T. 15 S, R. 85 W,* 2 (UMMZ); Almont, 2 (USNM); *1 mi. S Almont, 8000 ft.,* 1 (KU); Biebel Spring [5 2/10 mi. NE Gunnison], 7820 ft., 1 (WSC); *1/4 mi. SW Biebel Spring,* 1 (WSC); *7 1/2 mi. W Gunnison,* 1 (WSC); *1 mi. S Gunnison,* 3 (WSC); 3 mi. S, 6 mi. W Gunnison, 7600 ft., 2 (KU); *6 mi. SW Gunnison,* 1 (WSC); 6 mi. S Gunnison, 1 (WSC); Cochetopa Creek, 1 (WSC). CHAFFEE COUNTY: 5 mi. W Buena Vista, 1 (UMMZ); Salida, 1 (CU); *no locality other than county,* 1 (UMMZ). TELLER COUNTY: 10 mi. N Florissant, 8400 ft., 1 (CSU); 7 mi. NNE Florissant, 2 (FWS); Glen Cove, 3 (UMMZ). EL PASO COUNTY: Palmer Lake, 1 (DMNH); *Cascade, 8500 ft.,* 1 (USNM); *Minnehaha, 8400 ft.,* 1 (UMMZ); Pikes Peak, 1 (MCZ); *near Colorado Springs,* 1 (WC); Colorado Springs, 1 (WC); Lake Moraine, 10,250 ft., 6 (2 AMNH, 4 WC); *no locality other than county,* 2 (MCZ). MONTROSE COUNTY: Black Canyon of the Gunnison National Monument, 3 (CU). OURAY COUNTY: 23 mi. N Ridgway, 7200 ft., 1 (KU). SAGUACHE COUNTY: Bonanza, 1 (DMNH); Cochetopa Dome, 26 mi. SE Gunnison, 1 (CSU); *4 1/2 mi. N, 21 1/2 mi. W Saguache, 9300 ft.,* 1 (KU); *4 mi. N, 17 mi. W Saguache, 8500 ft.,* 1 (KU); *3 mi. N, 20 mi. W Saguache, 9000 ft.,* 1 (KU); *2 mi. N, 32 mi. W Saguache, 9800 ft.,* 1 (KU); Tevebaugh's Ranch, 20 mi. W Saguache, 3 (USNM); *15 mi. W Saguache,* 1 (DMNH); Saguache, 1 (AMNH); 2 mi. N, 2 mi. E Crestone, 8300 ft., 1 (KU). CUSTER COUNTY: Querida, 9000 ft., 1 (WC); San Isabel, 1 (SCSC). DOLORES COUNTY: 15 mi. N, 10 mi. E Dolores, 8250 ft., 2 (KU). SAN JUAN COUNTY: 6 1/2 mi. SW Silverton, 10,100 ft., 1 (KU). HINSDALE COUNTY: Hermit, 1 (USNM). ALAMOSA COUNTY: Sangre de Cristo Range, 24 mi. E Hooper, 4 (DMNH). LA PLATA COUNTY: 7 mi. N, 1 mi. E Hermosa, 8100 ft., 1 (KU); *8 mi. N, 2 mi. W Hesperus,* 1 (UI); 8 mi. N, 1 mi. W Hesperus, 9500 ft., 4 (KU); 21 mi. [by road] N Bayfield, 7400 ft., 4 (AMNH). ARCHULETA COUNTY: Gordon Creek, near junction with Piedra River, 3 (UNM); headwaters, Navajo River, 3 (DMNH); *Navajo River,* 2 (DMNH); Chromo, 3 (DMNH); *1 mi. S, 2 mi. W Chromo, 7200 ft.,* 1 (KU). CONEJOS COUNTY: Osier, 5 (DMNH). COSTILLA COUNTY: 5 mi. SSE Fort Garland, 3 (AMNH); 3 mi. W San Acacio, 8050 ft., 2 (KU); Culebra Cañon, 1 (WC).

Additional records (Finley 1958:259, unless otherwise noted): JACKSON COUNTY: Buffalo Pass Sawmill (Warren, 1926a:100). LARIMER COUNTY: *Log Cabin* (Warren, *loc. cit.*); *2 mi. E Log Cabin, 7450 ft.* GARFIELD COUNTY: 12 mi. above Glenwood Springs (Warren, 1926a:100). EAGLE COUNTY: no precise locality (Warren, 1942:217). GRAND COUNTY: near Fraser (Cary, 1911:111). BOULDER COUNTY: *Gregory Canyon* (Cockerell *et al.,* 1913:206); *Nederland* (Elliot, 1907:280). CLEAR CREEK COUNTY: *Mount McClellan* (Cary, 1911:111). LAKE COUNTY: Dayton (Coues and Yarrow, 1875:101). PARK COUNTY: *Mosquito Gulch; Mount Lincoln* (Blake and Blake, 1969:36). GUNNISON COUNTY (Durrant and Robinson, 1962: 251, unless otherwise noted): *Gothic* (Findley and Negus, 1953:238); Forest Reserve Camp, sec. 7, T. 49 N, R. 5 W, 8250 ft. (Finley, 1958:259); confluence of Beaver Creek and Gunnison River, 7600 ft.; *butte, 1 1/2 mi. NW Dry Gulch, 8300 ft.; 3/4 mi. NW Dry Gulch Camp, 7800 ft.; 2 mi. above junction Cebolla Creek and Gunnison River, 7550 ft.;* 5 1/2 mi. up Lake Fork, 7400 ft. CHAFFEE COUNTY: 8 1/2 mi. NE Buena Vista, 8750 ft. EL PASO COUNTY: *Bear Creek Canyon, 7100 ft.; Bear Creek, 8300 ft.; Hunter's Creek, tributary of Bear Creek.* SAGUACHE COUNTY: *Madenos [Medano] Cañon, above Herard's, 8700 ft.; 22 mi. W Saguache.* SAN JUAN COUNTY: *near Silverton* (Cary, 1911:111). CONEJOS COUNTY: *Rio Grande* (Coues and Yarrow, 1875:101). COSTILLA COUNTY: *Fort Garland* (Coues and Yarrow, *loc. cit.*).

Neotoma cinerea rupicola J. A. Allen

Neotoma rupicola J. A. Allen, Bull. Amer. Mus. Nat. Hist., 6:323, 7 November 1894; type locality, Corral Draw, 3700 ft., Pine Ridge Indian Reservation, Shannon Co., South Dakota.

Neotoma cinerea rupicola, Goldman, N. Amer. Fauna, 31:107, 19 October 1910.

Distribution in Colorado.—Rim of High Plains, northern Weld and Logan counties (Fig. 78).

Comparison.—For comparison with *N. c. orolestes,* the subspecies of central Colorado, see account of that taxon.

Measurements.—External measurements of two males and mean (and extremes) of four females, all from Pawnee Buttes, Weld County, are: 384, 362, 351.5 (332-369); 154, 153, 151.0 (145-156); 46, 44, 44.8 (44-46); 31, 32, 31.2 (31-32). Selected cranial measurements are presented in table 21.

Remarks.—*Neotoma c. rupicola* is a race of small, pallid woodrats adapted to the arid badlands of western parts of the Missouri Plateau and the High Plains. In Colorado, the subspecies occurs in canyons cut in soft Tertiary sediments by headward-cutting tributaries of the South Platte River. Warren

(1912b) described the habitat of *rupicola* at Pawnee Buttes.

Intergradation with *N. c. orolestes* in Colorado is unknown. Individuals of *N. c. rupicola* average slightly paler in color than *N. c. arizonae,* but are otherwise not notably dissimilar. The range of *orolestes* is interposed between those of *rupicola* and *arizonae,* however, and the similarities of the taxa apparently reflect parallel adaptation to arid habitats and a pale substrate.

Records of occurrence.—Specimens examined, 37, distributed as follows: WELD COUNTY: Battle Cañon, 2 (DMNH); *2 mi. N Geary Reservoir,* 1 (DMNH); 1 mi. N Geary Reservoir, 10 (DMNH); Pawnee Buttes, 5300 ft., 8 (3 USNM, 5 WC); 12 mi. NW New Raymer, 7 (CU). LOGAN COUNTY: 2 mi. S, 17 mi. W Peetz, 3 (KU); Chimney Cañon, 10 mi. NE Avalo, 2 (USNM); *21 mi. N, 5 mi. E Stoneham, 4700 ft.,* 4 (KU); 10 mi. E Avalo, 3 (USNM).

Additional records (Finley, 1958:273): LOGAN COUNTY: *sec. 3, T. 11 N, R. 54 W; sec. 21, T. 11 N, R. 53 W* (sight record); sec. 22, T. 11 N, R. 52 W (sight record).

Clethrionomys gapperi

Gapper's Red-backed Vole

Clethrionomys gapperi is a mammal of the boreal forest and in Colorado is mostly confined to sites with well-developed coniferous forest at moderate elevations in the mountains. The lowest record of occurrence in Colorado is from 6000 feet in Douglas County, but most records are from 8000 to 11,000 feet or higher. Red-backed voles seem to be most abundant in stands of lodgepole pine (*Pinus contorta*). In June 1968, I captured *Clethrionomys* near Gould, Jackson County, in traps set in a cone cache made by chickarees in a lodgepole stand. The voles were active by day.

No intensive study of the red-backed vole in Colorado has been made. L. P. Brown (1923) reported brief observations on behavior, and Vaughan (1969:66) presented data on reproduction and population densities in northwestern Grand County. Williams and Finney (1964) discussed food habits. Hooper and Hart (1962) described the glans penis of a red-backed vole from Rocky Mountain National Park. For a discussion of geographic variation in *C. gapperi* in the Southern Rocky Mountains, see Cockrum and Fitch (1952).

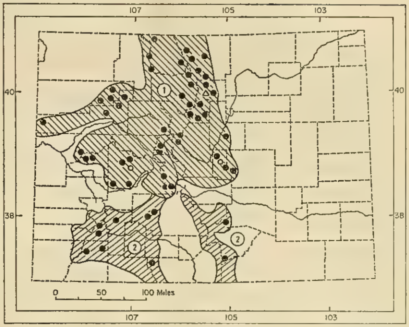


FIG. 79. Distribution of *Clethrionomys gapperi* in Colorado. 1. *C. g. galei.* 2. *C. g. gauti.* For explanation of symbols, see p. 9.

Clethrionomys gapperi galei (Merriam)

Evotomys galei Merriam, N. Amer. Fauna, 4:23, 8 October 1890; type locality, Ward, 9500 ft., Boulder Colorado (see remarks).

Clethrionomys gapperi galei, Hall, Univ. California Publ. Zool., 37:6, 10 April 1931.

Distribution in Colorado.—Mountains of central and northern parts of state (Fig. 79).

Comparisons.—For comparison with *C. g. gauti,* see account of that subspecies. According to the original description, *C. g. uintaensis* differs from *C. g. galei* in grayer head and cheeks, paler dorsum and sides, and "whiter" belly (Doutt, 1941:161).

Measurements.—Mean (and extreme) external measurements of six males from Boulder and Gilpin counties are: 130.0 (126-148), 38.5 (33-44), 18.5 (18-19), 13.3 (12-15), weight, 25.44 (21.7-29.4). Mean (and extremes) of seven males and five females from the Grand Mesa, Mesa and Delta counties are: 137.1 (132-145), 142.8 (139-149); 36.9 (34-39), 38.8 (34-42); 17.3 (16-19), 17.6 (14-16); 15.0 (14-16), 15.2 (14-16); weight, 25.08 (23.6-27.7), 28.54 (25.2-30.3). Representative cranial measurements are presented in table 22.

Remarks.—In his original description of *galei,* Merriam indicated the type locality to be "near Gold Hill." V. Bailey (1897:126) noted that the holotype had been collected at Ward. Both localities are in Boulder

TABLE 22

Selected cranial measurements of eight species of microtine rodents.

Number averaged (or catalog number), sex	Condylobasal length	Zygomatic breadth	Interorbital constriction	Prelambdoidal breadth	Lambdoidal breadth	Length of maxillary toothrow
Clethrionomys gapperi galei, Boulder and Gilpin counties						
Mean, 6 ♂	23.37	12.70	3.72	9.35	11.15	5.28
Minimum	22.9	12.3	3.5	9.0	10.8	5.0
Maximum	24.0	13.3	3.9	9.8	11.3	5.6
CU 5220, ♀	23.2	12.5	3.7	9.8	10.9	5.0
CU 20607, ♀	25.1	13.7	4.0	9.9	11.6	5.2
Grand Mesa, Mesa and Delta counties						
Mean, 7 ♂	23.39	13.07	3.61	9.20	11.27	5.17
Minimum	22.8	12.7	3.4	8.8	11.1	4.9
Maximum	23.6	13.4	3.8	9.6	11.5	5.4
Mean, 5 ♀	23.54	13.08	3.66	9.24	11.14	5.22
Minimum	23.0	12.8	3.5	9.0	10.8	5.0
Maximum	23.9	13.4	3.9	9.4	11.3	5.4
Clethrionomys gapperi gauti, southern Huerfano county						
KU 60030, ♂	25.4	14.0	3.9	9.9	12.0	5.0
KU 60043, ♂	25.0	13.5	4.0	9.7	11.8	5.4
KU 60031, ♀	25.2	13.1	3.8	9.7	11.5	5.4
Phenacomys intermedius intermedius, Grand Mesa, Delta County						
KU 60048, ♀	25.4	15.3	3.6	8.6	11.4	6.8
KU 60049, ♀	25.2	15.0	3.9	9.0	11.1	7.0
near Cucharas Camps, Huerfano County						
KU 60050, ♀	25.2	14.7	3.6	8.8	11.2	6.8
Microtus pennsylvanicus finitus, Dundy County, Nebraska						
KU 51630, ♂	29.7	16.2	3.8	9.5	12.7	7.8
KU 51640, ♂	31.6	16.8	3.9	9.4	13.5	7.8
KU 51645, ♂	29.9	16.9	3.7	9.9	13.1	7.8
Mean, 5 ♀	29.92	17.00	3.46	9.44	12.76	7.72
Minimum	29.5	16.1	3.2	8.9	12.0	7.4
Maximum	30.6	17.5	3.8	10.0	13.1	8.2
Microtus pennsylvanicus modestus, near Cochetopa Pass, Saguache County						
Mean, 4 ♂	27.30	15.40	3.58	9.30	12.40	6.58
Minimum	27.0	15.0	3.3	8.8	11.9	6.4
Maximum	27.9	16.1	3.8	10.0	13.1	6.7
eastern Costilla County						
Mean, 4 ♂	28.40	15.72	3.60	9.33	13.07	7.17
Minimum	27.7	15.2	3.5	9.2	12.6	6.7
Maximum	28.9	15.9	3.7	9.6	13.3	7.8
vicinity of Monument Lake, Las Animas County						
Mean, 7 ♀	28.32	15.41	3.79	9.68	12.59	7.09
Minimum	27.7	15.2	3.7	9.3	12.2	6.9
Maximum	29.0	15.7	3.9	9.9	12.9	7.3

TABLE 22 (Continued)

Selected cranial measurements of eight species of microtine rodents.

Number averaged (or catalog number), sex	Condylobasal length	Zygomatic breadth	Interorbital constriction	Prelambdoidal breadth	Lambdoidal breadth	Length of maxillary toothrow
Microtus pennsylvanicus uligocola, W of Loveland, Larimer County						
KU 26870, ♂	29.4	16.3	3.5	9.0	13.0	7.2
KU 26897, ♂	29.4	16.4	3.7	10.8	13.3	7.2
KU 26860, ♀	30.2	17.7	3.4	9.4	13.7	7.5
KU 26894, ♀	29.4	16.5	3.4	9.5	12.6	7.7
Microtus montanus fusus, vicinity of Cochetopa Pass, Saguache County						
KU 42308, ♂	26.1	15.3	3.4	8.2	11.9	6.6
KU 42300, ♀	26.2	14.7	3.5	8.6	11.5	6.2
San Juan Mountains						
KU 16036, ♂	27.4	14.8	3.5	8.9	12.3	6.4
KU 42327, ♂	27.3	15.4	3.5	8.6	12.0	6.4
KU 42322, ♀	26.8	15.4	3.4	8.6	11.6	6.6
KU 42323, ♀	26.5	14.9	3.6	8.9	11.5	6.2
Grand Mesa, Mesa and Delta counties						
Mean, 7 ♂	27.32	15.44	3.61	8.82	12.20	6.49
Minimum	26.5	14.7	3.4	8.5	11.8	6.3
Maximum	27.8	16.2	3.9	9.2	12.5	6.9
Microtus montanus nanus, Larimer County and adjacent Albany County, Wyoming						
Mean, 6 ♂	27.49	15.94	3.59	8.77	12.33	6.33
Minimum	26.7	14.8	3.4	8.5	11.7	5.9
Maximum	28.1	16.4	3.7	9.2	12.9	6.7
Mean, 10 ♀	27.01	15.24	3.43	8.64	11.84	6.40
Minimum	26.6	14.6	3.2	7.9	11.2	6.2
Maximum	27.8	16.4	3.7	9.1	12.3	6.7
Microtus mexicanus mogollonensis, Mesa Verde National Park, Montezuma County						
KU 69453, ♂	26.9	15.7	3.5	8.9	12.4	6.6
KU 102073, ♂	26.7	15.7	3.5	9.0	12.3	6.4
KU 102070, ♀	27.3	16.1	3.4	8.6	12.3	7.1
Microtus longicaudus longicaudus, vicinity of Estes Park, Larimer County						
KU 20739, ♂	27.7	15.6	3.7	9.7	12.7	6.8
KU 26791, ♂	26.8	15.4	3.7	10.3	12.6	6.5
KU 59102, ♂	28.1	15.9	3.6	10.1	13.1	7.0
9 1/2 mi. SE Pagoda Peak, 7700 ft., Rio Blanco County						
KU 20705, ♂	27.8	16.4	3.6	10.2	12.8	6.6
KU 20710, ♂	29.2	16.3	3.6	10.5	13.4	7.0
KU 20711, ♂	28.5	16.0	3.8	9.5	12.7	6.7
near Cucharas Camps, Huerfano County						
KU 60081, ♂	28.0	15.9	3.8	10.2	13.2	6.9
KU 60087, ♂	27.3	15.6	3.8	9.8	12.7	6.6
KU 60091, ♂	26.9	15.4	3.7	9.9	12.7	7.0
Microtus ochrogaster haydenii, W of Loveland, Larimer County						
Mean, 6 ♂	29.45	16.55	3.97	9.78	12.75	7.22
Minimum	28.2	15.8	3.5	9.4	12.0	6.6
Maximum	30.5	17.4	4.2	10.4	13.3	7.4

TABLE 22 (Continued)

Selected cranial measurements of eight species of microtine rodents.

Number averaged (or catalog number), sex	Condylobasal length	Zygomatic breadth	Interorbital constriction	Prelambdoidal breadth	Lambdoidal breadth	Length of maxillary toothrow
Microtus ochrogaster haydenii, W of Loveland, Larimer County						
Mean, 5 ♀	29.34	16.72	3.66	9.60	12.78	6.86
Minimum	28.9	16.5	3.4	9.1	12.6	6.6
Maximum	30.1	16.8	3.8	10.4	12.9	7.1
Lagurus curtatus levidensis, Moffat County						
Mean, 4 ♂	23.92	13.70	3.30	8.75	10.52	5.78
Minimum	23.1	13.4	3.2	8.3	10.2	5.6
Maximum	24.2	14.1	3.5	9.4	11.1	6.0
Mean, 6 ♀	22.89	13.50	3.35	8.79	10.35	5.72
Minimum	22.3	13.0	3.2	8.4	9.9	5.4
Maximum	23.6	14.0	3.5	9.6	11.2	6.1

County; Ward is about 3/4 mi. N and 5 1/2 mi. W of Gold Hill, and about 850 feet higher in elevation.

Available material from Colorado indicates remarkable variation in color of specimens from a given locality. The shade and texture of the dorsal reddish hairs varies with age and seasonally as does that of the dorsal stripe. Variation in color of the venter also is marked. Among adults captured on the same date at a place 12 mi. S and 5 1/2 mi. E of Collbran, *in* Delta County, the color of the venter varies from buffy to nearly white, the usual color, however, being silvery gray. Color is not diagnostic of Coloradan subspecies, but for the most part cranial characters do separate red-backed voles from the south-central part of the state. As indicated by Cockrum and Fitch (1952:289), specimens from western Saguache County apparently are intergrades between *galei* and *gauti*, referable to the latter subspecies. The apparent intergrades are from the Cochetopa Hills, the only highland connection between the ranges of the two populations.

Clethrionomys gapperi presently is unknown from Moffat County. In the event that the species should be found to occur along the Green River in the extreme western part of that county, *C. g. uintaensis* is the subspecies to be expected. Cockrum and Fitch (1952: 288) were of the opinion that the subspecies is but weakly differentiated from *C. g. galei*, and Long (1965:643) regarded the two as inseparable. Nonetheless, red-backed voles of the Uinta Mountains presently are isolated by an appreciable extent of unsuitable habitat from populations in central Colorado and south-central Wyoming.

Records of occurrence.—Specimens examined, 254, distributed as follows: ROUTT COUNTY: Dome Peak, 2 (DMNH); Rabbit Ears Pass, 9680 ft., 8 (CM); *2 mi. SW Rabbit Ears Pass, 9800 ft.*, 2 (CSU). JACKSON COUNTY: Pearl, 9000 ft., 1 (CU); 2 mi. N, 2 mi. E Gould, 8600 ft., 2 (KU). LARIMER COUNTY: Rawah Wilderness Area, 10,000 ft., 4 (CSU); Pingree Park, 9000 ft., 2 (CSU); Chambers Lake, 2 (CSU); 8 mi. WNW Estes Park, 1 (FHSC); *3 mi. N, 11 mi. W Estes Park, 11,000 ft.*, 1 (UI); Fall Creek, 9700 ft., 1 (USNM); *Willow Park, Rocky Mountain National Park*, 4 (UMMZ); *near Upper Hidden Valley*, 5 (RMNP); *above Hidden Valley Lodge*, 1 (RMNP); *Hidden Valley*, 13 (RMNP); *Rocky Mountain National Park, 10,000 ft.*, 2 (UI); *Bear Lake*, 1 (DMNH); Longs Peak, 6 (USNM). RIO BLANCO COUNTY: 9 1/2 mi. SW Pagoda Peak, 7700 ft., 2 (KU); *Lost Creek, 9 mi. NE Buford*, 3 (CM); White River Plateau, 2 (USNM); 15 mi. SE Meeker, 16 (CM). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 10 (AMNH); *Stillwater Reservoir*, 1 (DMNH); Deep Lake, 16 mi. N Glenwood Springs, 2 (KU); *8 mi. SE South Fork Campground, White River National Forest, 10,860 ft.*, 2 (1 CSC, 1 CSU); Mud Springs, 8850 ft., 2 (AMNH); Baxter Pass, 8500 ft., 3 (USNM). EAGLE COUNTY: 10 mi. N, 1 mi. W Leadville, 1 (KU). GRAND COUNTY: Kawuneeche Residence Area, 2 (RMNP); Grand Lake, 8300 ft., 3 (2 AMNH, 1 DMNH); *3 mi. S, 2 mi. W*

Grand Lake, 6 (UNM); Coulter, 5 (USNM); 1 mi. N Berthoud Pass, 1 (KU). BOULDER COUNTY: *3/4 mi. N, 2 mi. W Allenspark, 8400 ft.,* 2 (KU); 12 1/2 mi. S Estes Park, 8400 ft., 2 (KU); Ward, 1 (USNM); *10 mi. NW Nederland, 10,000 ft.,* 1 (CU); Gold Hill, 8400 ft., 3 (1 CU, 2 USNM); *head Fourmile Creek, 10,200 ft.,* 1 (UI); *3 mi. SSW Ward, 9500 ft.,* 1 (CU); *1/4 mi. S, 1/2 mi. E Science Lodge,* 2 (UI); *1/4 mi. W Sunset,* 1 (CU); *6 mi. NW Nederland, 10,000 ft.,* 3 (2 CSU, 1 CU); *4 1/2 mi. N, 1 mi. W Nederland,* 1 (FHSC); *Silver Lake Trail, [near] Nederland,* 3 (USNM); *Nederland,* 6 (3 ANSP, 3 FHSC); *Eldora,* 1 (CU). GILPIN COUNTY: *Tolland,* 2 (CU); *4 mi. S Nederland,* 1 (CU); *Moon Gulch, 3 mi. W Rollinsville,* 1 (CU); Moon Gulch, 2 1/2 mi. SW Rollinsville, 4 (CU); *end of Moon Gulch, SW of Rollinsville,* 1 (CU). CLEAR CREEK COUNTY: *8 mi. W Idaho Springs,* 1 (CSC); 2 mi. S Idaho Springs, 8000 ft., 1 (KU); Torrey's Peak, 7 (DMNH); *Silverplume,* 2 (SC); S side Mount Evans, near timberline, 1 (CU); *no locality other than county,* 1 (SC); *Hermann Gulch* (not found), 2 (SC). MESA COUNTY: Grand Mesa, 28 mi. E Grand Junction, 1 (KU); *Grand Mesa,* 1 (CSU). LAKE COUNTY: 8 mi. SW Leadville, 10,000 ft., 5 (KU); 3 mi. W Twin Lakes, 3 (KU). PARK COUNTY: Mount Bross, 6 (DMNH); *Sacramento Creek, 3 mi. above South Platte River,* 1 (DMNH); 3 1/2 mi. W Fairplay, 10,400 ft., 1 (UI). DOUGLAS COUNTY: Garber Canyon, 6000 ft., 1 (DMNH). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 17 (KU); 1 1/2 mi. S, 8 mi. E Skyway, 9500 ft., 5 (KU). GUNNISON COUNTY: *Copper Lake,* 2 (KU); Sylvanite Basin, 6 mi. N Gothic, 1 (KU); *Quigley Creek, Gothic Natural Area,* 6 (UI); *Sylvanite Basin, 2 mi. N Gothic,* 1 (UNM); *2 mi. N Gothic,* 3 (KU); *2 mi. W Gothic,* 2 (UNM); *Gothic,* 9 (2 ANSP, 1 UNM, 6 USNM); *Rocky Mountain Biological Laboratory,* 1 (USNM); *Irwin, 10,700 ft.,* 6 (4 AMNH, 1 CSU, 1 MCZ); near Beckwith Pass, 1 (UNM); Black Mesa, 9 mi. WNW Sapinero, 9500 ft., 1 (KU); 7 1/2 mi. W Gunnison, 7050 ft., 1 (FWS); *Jackson Ranger Station* (not found), 6 (SC). CHAFFEE COUNTY: St. Elmo, 10,100 ft., 1 (USNM); 17 mi. W Salida, 11,000 ft., 1 (CM). TELLER COUNTY: 7 mi. NNE Florissant, 1 (FWS); Glen Cove, 11,350 ft., 1 (UMMZ). EL PASO COUNTY: *Minnehaha,* 1 (UMMZ); *Halfway,* 1 (UMMZ); Lake Moraine, 10,250 ft., 7 (AMNH).

Additional records: JACKSON COUNTY: *[near] Lake Agnes* (Yeager, 1950:329). GARFIELD COUNTY: *Trappers Lake* (Yeager, *loc. cit.*); *Coffee Pot Springs [sec. 19, T. 4 S, R. 87 W], 10,000 ft.,* (Bradley, 1967:198). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). BOULDER COUNTY: *E of Science Lodge, about 9600 ft.* (Williams and Finney, 1964:265). GILPIN COUNTY: *Jumbo Mountain* (Williams and Finney, 1967:74). GUNNISON COUNTY: *Copper Lake Basin* (Findley and Negus, 1953:236); Crested Butte (Warren, 1906:249). TELLER COUNTY: Divide (Warren, *loc. cit.*).

Clethrionomys gapperi gauti
Cockrum and Fitch

Clethrionomys gapperi gauti Cockrum and Fitch, Univ. Kansas Publ., Mus. Nat. Hist., 5:289, 15 November 1952; type locality, Twining, 10,700 ft., Taos Co., New Mexico.

Distribution in Colorado.—In suitable habitat in mountainous areas south of Gunnison and Arkansas rivers (Fig. 79).

Comparison.—From *C. g. galei,* the subspecies of central and northern Colorado and adjacent Wyoming, *C. g. gauti* differs in paler color, slightly narrower dorsal reddish stripe, and ochraceous buff rather than silvery white venter; cranially, *gauti* differs in greater zygomatic and lambdoidal breadth, slightly shorter nasals, larger cheekteeth, and more inflated auditory bullae (see Cockrum and Fitch, 1952:289).

Measurements.—External measurements of two males and a female from extreme southern Huerfano County are: 143, 152, 152; 41, 42, 42; 19, 19, 19; 16, 16, 16; 35.5, 37.2, 32.0. Selected cranial measurements are presented in table 22.

Remarks.—Intergradation with *C. g. galei* apparently occurs in the Cochetopa Hills, and is discussed in the account of that subspecies.

Probably Poncha Pass is a barrier to red-backed voles and separates those of the Sangre de Cristo and adjacent ranges from those of the San Juan Mountains. Farther south the Rio Grande Valley must be a strong barrier, so that today the nominal subspecies *C. g. gauti* probably is polytopic.

Records of occurrence.—Specimens examined, 49, distributed as follows: OURAY COUNTY: Red Mountain Pass, 2 (SC). SAGUACHE COUNTY: 3 mi. N, 21 mi. W Saguache, 3 (KU); Saguache Park, 1 (USNM). CUSTER COUNTY: San Isabel, 1 (FWS). SAN JUAN COUNTY: Silverton, 7 (USNM). HINSDALE COUNTY: Crystal Lake, 5 mi. S Lake City, 1 (USNM). HUERFANO COUNTY: 5 mi. S, 1 mi. W Cucharas Camps, 22 (KU). LA PLATA COUNTY: 21 mi. N Bayfield, 4 (AMNH); 8 mi. N, 2 mi. W Hesperus, 1 (UI). CONEJOS COUNTY: "3-5 mi. SW Platoro," 7 (FHSC).

Phenacomys intermedius

HEATHER VOLE

The heather vole occurs over much of Colorado at higher elevations, although specimens never have been captured on the high plateaus of the western part of the state except on Grand Mesa. The maximum elevation from which specimens have been examined is 12,100 feet, on the eastern slope of the Sangre de Cristo Range in Custer County; the lowest records of occurrence are at about 7000 feet. Heather voles have been considered rare. Evidently the species is widespread but not usually abundant at a given locality.

Phenacomys intermedius has been captured in a variety of habitats in Colorado. Williams (1952, 1955b) collected specimens along a stream, in lodgepole and ponderosa pine forests, and in a partially recovered burn in western Gilpin County. The streamside community evidently was preferred. Miller and Landberg (1931) captured a specimen at the base of a spruce along a stream near Alma, Park County. Pruitt (1954) commented on the distribution of the species near Gothic, Gunnison County; there a specimen was captured in krummholz at an elevation of about 10,500 feet. In southern Jackson County, specimens were obtained in rank grasses among willows along the North Fork of the Michigan River.

Notes on reproduction of Coloradan *Phenacomys* were presented by Vaughan (1969:66); Williams and Finney (1964) briefly noted food habits. Hooper and Hart (1962) described the glans penis of a heather vole from Rocky Mountain National Park.

Phenacomys intermedius intermedius Merriam

Phenacomys intermedius Merriam, N. Amer. Fauna, 2:32, 30 October 1889; type locality, 20 mi. WNW Kamloops, 5500 ft., British Columbia.

Phenacomys preblei Merriam, Proc. Biol. Soc. Washington, 11:45, 16 March 1897; type locality, side of Twin Peak, 9000 ft., near Longs Peak, Boulder Co., Colorado (regarded as inseparable from *intermedius* by A. B. Howell, 1926:15).

Distribution in Colorado.—Forested mountains of central part of state (Fig. 80).

Measurements.—External measurements of females from the Grand Mesa, Delta County, and from extreme southern Huerfano County, are: 139, 138; 37, 33; 19, 18; 15, 16; weights, 33.5, 40.1. Representative cranial measurements are presented in table 22.

Remarks.—Insufficient samples of adults

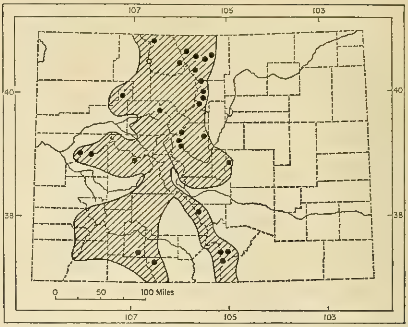


FIG. 80. Distribution of *Phenacomys intermedius intermedius* in Colorado. For explanation of symbols, see p. 9.

are available from localities in Colorado to permit adequate assessment of variation within populations, but the available material suggests considerable individual variation in such cranial features as breadth and convexity of nasals, inflation of parietals and supraoccipital, and size and shape of prelambdoidal fenestrae.

The holotype of *P. preblei* is an immature male (USNM 74513). Characteristics supposedly distinctive in *preblei* are matched by specimens from other localities in Colorado and elsewhere in the range of *intermedius.* I have not examined specimens of *intermedius* from the vicinity of the type locality, but Coloradan specimens of *Phenacomys* are not distinguishable from specimens from Teton County, Wyoming.

Records of occurrence.—Specimens examined, 51, distributed as follows: JACKSON COUNTY: 3 mi. S Pearl, 1 (CSU); 2 mi. N, 2 mi. E Gould, 4 (KU). LARIMER COUNTY: Rawah Wilderness Area, T. 9 N, R. 76 W, 10,000 ft., 1 (CSU); Rawah Lake No. 3, 10,300 ft., 1 (CSU); 4 mi. N, 12 mi. W Fort Collins, 7400 ft., 1 (CSU); Cache la Poudre River, 9500 ft., 1 (USNM); Pingree Park, 1 (KU); Fall River Pass, 1 (UMMZ); Willow Park, 2 (UMMZ); 1/4 mi. above Upper Hidden Valley, 1 (RMNP). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 2 (CM). EAGLE COUNTY: 20 mi. S Kremmling, 1 (CSU). SUMMIT COUNTY: Hoosier Pass, 1 (DMNH). BOULDER COUNTY: Twin Peak, 9000 ft., 1 (USNM); 3 mi. S Ward, 9000 ft., 1 (KU); *6 mi. NW Nederland, 10,600 ft.,* 1 (CSU); Nederland, 1 (ANSP). GILPIN COUNTY: Moon Gulch, 2 1/2 mi. SW Rollinsville, 8750 ft., 3 (CU). MESA COUNTY: Grand Mesa, 28 mi. E Grand Junction, 1 (KU). PARK COUNTY: 2 1/2 mi. S Estabrook, 2 (FHSC); *3 mi. N Alma,* 1 (DMNH); Alma, 1 (DMNH); Fairplay, 1 (USNM). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 10,000 ft., 1 (KU); *1/2 mi. S, 8 mi. E Skyway, 10,000 ft.,* 1 (KU). GUNNISON COUNTY: Quigley Creek, Gothic Natural Area, 10,300 ft., 1 (UMMZ); *Gothic Primitive Area, 10,500 ft.,* 1 (UMMZ). EL PASO COUNTY: 9 mi. N Colorado Springs, 7200 ft., 1 (CSU). CUSTER COUNTY: slope E of Horseshoe Lake, 12,100 ft., 1 (WC). MINERAL COUNTY: Wolf Creek Pass, 10,850 ft., 1 (CSU). HUERFANO COUNTY: 8 mi. W La Veta, 1 (UMMZ); La Veta, 1 (UMMZ); 5 mi. S, 1 mi. W Cucharas Camps, 10,000 ft., 10 (KU). CONEJOS COUNTY: "3-5 mi. SW Platoro," 2 (FHSC).

Additional records: JACKSON COUNTY: Buffalo Pass, 10,000 ft. (Warren, 1912a:3). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). BOULDER COUNTY: *North Boulder Creek, about 2900 m. [about 9500 ft.]* (R. T. Young, 1908:406); *E of Science Lodge, about 9600 ft.,* (Williams and Finney, 1964:265); *5 mi. E Science Lodge, 10,000 ft.* (Williams and Finney, *loc. cit.*). GILPIN COUNTY: *Mount Jumbo, 9800 ft.* (Williams, 1952:399). GUNNISON COUNTY: *NE slope Gothic Mountain, about 10,500 ft.* (Findley and Negus, 1953:238).

Microtus pennsylvanicus

Meadow Vole

The meadow vole has the most extensive range of any North American species of the genus *Microtus.* In Colorado, the pattern of distribution is particularly interesting. *Microtus pennsylvanicus* is not known to occur in North Park, or on the Western Slope north or west of the Upper Gunnison Valley. A hiatus in the known range exists along the divide between the South Platte and Arkansas rivers in southern Park and northern Fremont counties. The pattern of distribution of the montane populations suggests expansion from two centers, one in the San Luis Valley, the other in or near the Front Range in the South Platte Valley.

In part, differences among distributional patterns of Coloradan microtines result from differences in requisite habitat. *M. pennsylvanicus* in Colorado is closely restricted to wetlands. Typical habitat is permanently boggy situations in open valleys and parks, and the periphery of springs in the San Luis Valley. Comparable situations are occupied on the eastern plains. Areas with less dependable water, such as streamside herb communities, seldom are inhabited, and are occupied by other species—*M. ochrogaster* on the plains in the South Platte Valley, and *M. montanus* or *M. longicaudus* in the mountains. The predilection for hydrosere communities with abundant standing water dictates a spotty local distribution for *M. pennsylvanicus* in Colorado, and mountain ranges with a youthful drainage pattern apparently present barriers to expansion. For comments on the role of competition in distribution of species of *Microtus,* see Findley (1954a), and also Koplin and Hoffmann (1968). Cruzan (1968) studied ecological relationships of four species of the genus *Microtus* near Boulder. For comments on the natural history of some Coloradan species of *Microtus,* see Burnett (1916a).

Anderson (1956) studied geographic variation in Coloradan meadow voles, and accounts of subspecies generally follow that study.

Microtus pennsylvanicus finitis Anderson

Microtus pennsylvanicus finitis Anderson, Univ. Kansas Publ., Mus. Nat. Hist., 9:96, 10 May 1956; type locality, 5 mi. N, 2 mi. W Parks, Dundy Co., Nebraska.

Distribution in Colorado.—Known only from drainage of North Fork of Republican River, eastern Yuma County (Fig. 81).

Comparison.—From *M. p. uligocola,* the subspecies of the South Platte drainage to the north and west, *M. p. finitis* differs in darker color and in cranial details (see Anderson, 1956:96).

Measurements.—A series of adults from Colorado is not available. External measurements of two males and the mean (and extremes) of five females, topotypes from Dundy County, Nebraska, are: 176, 187, 173.8 (168-176); 45, 47, 43.6 (40-46); 22, 23, 21.4 (21-22); 12, 16, 12.4 (11-14); weights of three males, 58.7, 75.0, 62.7, of two females, 61.1, 50.4. For cranial measurements, see table 22.

Records of occurrence.—Specimens examined, 7, distributed as follows: YUMA COUNTY: *1 mi. W Laird,* 2 (KU); Wray, 5 (3 USNM, 2 WC).

Microtus pennsylvanicus modestus (Baird)

Arvicola modesta Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):535, 14 July

1858; type locality, Sawatch [Cochetopa] Pass, Saguache Co., Colorado.

Microtus pennsylvanicus modestus, V. Bailey, N. Amer. Fauna, 17:20, 6 June 1900.

Distribution in Colorado.—South-central part of state, south of Arkansas River (Fig. 81).

Comparison.—From *M. p. uligocola,* the subspecies of north-central Colorado, *M. p. modestus* differs in having darker dorsal color, a narrower skull, and a shorter average maxillary toothrow. For detailed comparisons, see Anderson (1956:93).

Measurements.—Mean (and extreme) external measurements of four males from the vicinity of Cochetopa Pass, four males from eastern Costilla County, and eight females from near Monument Lake, Las Animas County, are, respectively: 167.5 (160-175), 171.8 (168-179), 168.6 (158-184); 44.0 (38-47), 43.0 (40-45), 45.1 (42-49); 20.8 (20-22), 20.5 (20-21); 21.1 (20-22); 15.5 (14-17), 13.0 (11-14), 16.6 (15-18); weight, 49.90 (46.4-52.4), 60.02 (56.2-65.1), —. For cranial measurements, see table 22.

Remarks.—Anderson (1956:94) noted a questionable record of *M. pennsylvanicus* from Trinchera, Las Animas County, based on a skin without skull in the Denver Museum. The specimen in question was not seen by me. The possibility exists that the specimen was from Trinchera Peak, in the Culebra Range, and not from Trinchera, the town. On the other hand, specimens are now available from near Monument Lake on the Park Plateau, bridging a considerable gap in the range, so that a record from near the end of Raton Mesa no longer seems so aberrant. Nonetheless, following Anderson *(loc. cit.)*, the record is considered questionable on ecological grounds and the locality in question is not mapped on figure 81.

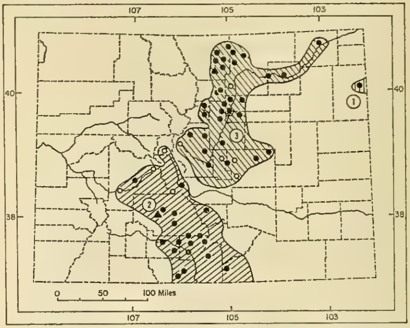


FIG. 81. Distribution of *Microtus pennsylvanicus* in Colorado. 1. *M. p. finitus.* 2. *M. p. modestus.* 3. *M. p. uligocola.* For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 222, distributed as follows: GUNNISON COUNTY: Ohio Creek, 6 mi. N Gunnison, 1 (WSC); *Ohio Creek,* 1 (WSC); *near Ohio Creek, Gunnison,* 1 (WSC). CHAFFEE COUNTY: Salida, 3 (WC). SAGUACHE COUNTY: *5 mi. N, 26 mi. W Saguache, 9500 ft.,* 2 (KU); 3 mi. N, 16 mi. W Saguache, 8500 ft., 5 (KU); Cochetopa Pass, 33 mi. W Saguache, 10,000 ft., 6 (1 KU, 5 USNM); *Monshower Meadows, 3 mi. E Cochetopa Pass,* 8 (USNM); *Tevebaugh's Ranch, 20 mi. W Saguache,* 73 (USNM); Saguache, 1 (FWS); 10 mi. S Saguache, 1 (FWS); *5 mi. NW Hooper,* 2 (1 AMNH, 1 DMNH); *9 mi. E Center,* 7 (AMNH). CUSTER COUNTY: Westcliffe, 7800 ft., 1 (WC). RIO GRANDE COUNTY: 8 mi. ENE Monte Vista, 1 (ASC); Del Norte, 2 (USNM); 8 mi. S Monte Vista, 7660 ft., 37 (UI). ALAMOSA COUNTY: Medano Ranch, 15 mi. NE Mosca, 2 (1 USNM, 1 WC); Hooper, 2 (AMNH); near Visitor's Center, Great Sand Dunes National Monument, 1 (GSDNM); *Mosca,* 5 (WC); *1/2 mi. S Uracca [Verracca] Pioneer Cemetery, 8800 ft.,* 14 (KU); Alamosa, 3 (UMMZ). CONEJOS COUNTY: 1 1/2 mi. E Manassa, 10 (KU); Antonito, 7 (USNM). COSTILLA COUNTY: Fort Garland, 15 (USNM). LAS ANIMAS COUNTY: [Parsons Ranch, NE of Monument Lake, about 20 mi. NW] Weston, 11 (CU).

Additional records: LAKE COUNTY: Twin Lakes (Coues and Yarrow, 1875:106). GUNNISON COUNTY (Durrant and Robinson, 1962:252, unless otherwise indicated): Taylor River (Coues and Yarrow, 1875:106); *Gunnison River, 7600 ft.;* East Elk Creek, 1 1/2 mi. N Gunnison River, 7429 ft.; *Gunnison River, 1/2 mi. N Willow Creek, 7600 ft.; Gunnison River, 1 mi. below Steuben Creek, 7430 ft.; 1/4 mi. above mouth Willow Creek, 7600 ft.* CHAFFEE COUNTY: Halfmoon Creek (Coues and Yarrow, 1875:106). COSTILLA COUNTY: *near Blanca* (Longhurst, 1942:282); *2 mi. S Blanca, 7800 ft.* (Anderson, 1956:94). LAS ANIMAS COUNTY: *Trinchera* (Anderson, *loc. cit.*—see remarks).

Microtus pennsylvanicus uligocola Anderson

Microtus pennsylvanicus uligocola Anderson, Univ. Kansas Publ., Mus. Nat. Hist., 9:94, 10 May 1956; type locality, 1/2 mi. S, 6 mi. W Loveland, Larimer, Co., Colorado.

Distribution in Colorado.—Valley of South Platte River and in mountains of Eastern

Slope, east on Platte-Arkansas Divide at least to Ramah (Fig. 81).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa.

Measurements.—External measurements of three males and two females from near Loveland, Larimer County, are: 192, 180, 185, 187, 178; 54, 44, 67, 56, 50; 23, 21, 22, 23, 22; 15, —, 13, 15, 14; weights, 73, 61, —, 68, 49. For additional measurements, see Anderson (1956: 100). Selected cranial measurements are presented in table 22.

Remarks.—A single specimen of *M. pennsylvanicus* is available from the South Platte Valley east of Fort Morgan; the specimen (WSC, uncatalogued) is an immature individual, and reference to *uligocola* is on geographic grounds. This usage follows that of Anderson (1956) in restricting the name *finitis* to the population along the North Fork of the Republican River in Yuma County and adjacent Nebraska, and in supposing that *uligocola* is not in contact with nominotypical *pennsylvanicus* along the South Platte.

Records of occurrence.—Specimens examined, 473, distributed as follows: LARIMER COUNTY: 14 8/10 mi. NNE Fort Collins, 2 (CSU); *1/2 mi. N, 3 mi. E Wellington,* 2 (CU); *2 mi. E Wellington,* 5 (2 CSU, 3 CU); *2 1/4 mi. E Wellington,* 2 (CSU); *3 mi. E Wellington, 5200 ft.,* 3 (CSU); *10 mi. NE Fort Collins,* 1 (CSU); *9 mi. NE Fort Collins,* 1 (CU); *6 mi. N, 2 mi. W Fort Collins, 5200 ft.,* 2 (CSU); *6 mi. N, 7 mi. E Fort Collins,* 1 (CSU); *8 1/2 mi. NE Fort Collins,* 1 (CU); *8 mi. NE Fort Collins,* 3 (1 CSU, 2 CU); 7 mi. NW Fort Collins, 2 (CSU); *5 mi. N Fort Collins,* 4 (CU); *5 mi. N, 5 mi. E Fort Collins,* 1 (CU); *4 mi. N, 2 mi. E Fort Collins,* 2 (CSU); *Cobb Lake,* 1 (CSU); *6 mi. NE Fort Collins,* 1 (CSU); *2 3/10 mi. N, 5 mi. E Fort Collins,* 3 (CSU); *1 mi. N, 4 mi. W Fort Collins,* 2 (CU); *1 mi. N, 1 3/4 mi. E Fort Collins,* 1 (CSU); *1 mi. N, 1 mi. W Fort Collins,* 2 (CU); *2 mi. NW Fort Collins,* 2 (CU); *1 mi. N Fort Collins, 5000 ft.,* 2 (1 CSC, 1 CSU); *1/2 mi. N Fort Collins,* 2 (CU); Fort Collins, 9 (6 CSU, 3 CU); *1/8 mi. E Fort Collins,* 1 (CSU); *Cache la Poudre River, Fort Collins,* 2 (CSU); *1 9/10 mi. E Fort Collins,* 1 (CSU); *1/4 mi. SE Fort Collins,* 1 (CSU); 1/2 mi. S, 6 mi. W Fort Collins, 5200 ft., 18 (KU); *1/2 mi. S, 1 1/4 mi. E Fort Collins,* 2 (CSU); *College Farm, Fort Collins,* 1 (CSU); *S of Fort Collins,* 3 (CU); *1 mi. SE Fort Collins,* 1 (CSU); *1 1/2 mi. SW Fort Collins,* 2 (CU); *Spring Creek, SE of Fort Collins,* 1 (CSC); *Dixon Lake,* 1 (CSU); *2 mi. S, 1 1/2 mi. W Fort Collins,* 1 (CU); *2 mi. S, 2 mi. E Fort Collins,* 4 (CSU); *2 mi. S, 3 mi. E Fort Collins,* 1 (CSU); *4 1/2 mi. SW Fort Collins, 5200 ft.,* 3 (CSU); *4 1/2 mi. SE Fort Collins, 4900 ft.,* 3 (CSU); *SE 1/4 sec. 30, T. 7 N, R. 68 W, 4950 ft.,* 1 (CSU); *5 mi. SE Fort Collins,* 1 (CSU); *4 mi. S, 1/4 mi. W Fort Collins,* 1 (CSU); *6 mi. SE Fort Collins,* 1 (CSU); *4 1/2 mi. S Fort Collins,* 2 (CSU); *5 mi. S, 1/2 mi. W Fort Collins,* 1 (CSU); *7 mi. SE Fort Collins,* 4 (CSU); *U.S. Highway 87 at Fossil Creek,* 1 (CSU); 3 mi. N Loveland, 8 (KU); *2 mi. N Loveland,* 2 (CSU); *4 mi. W Loveland,* 1 (CU); *Loveland,* 1 (USNM); 1/2 mi. S, 6 mi. W Loveland, 18 (KU). WELD COUNTY: 10 mi. NE Fort Collins, 1 (CSU); 3 mi. N, 19 mi. E Fort Collins, 1 (CSU); *2 mi. N, 9 mi. E Fort Collins,* 2 (CU); *9 mi. E Fort Collins,* 2 (CU); 3 mi. S, 9 mi. E Fort Collins, 1 (CSU). MORGAN COUNTY: 4 mi. W Orchard, 1 (UMMZ); *Orchard,* 4 (UMMZ); Muir Springs, 2 mi. N, 2 1/2 mi. W Fort Morgan, 2 (KU). LOGAN COUNTY: 4 mi. W Proctor, 1 (WSC). BOULDER COUNTY: 4 mi. N, 4 mi. E Boulder, 2 (UI); *White Rocks,* 2 (CU); *Valmont,* 1 (CU); Boulder, 149 (16 ANSP, 121 FMNH, 12 CU); *foot of First Flatiron, Boulder,* 2 (CU); *Skunk Canyon,* 1 (CU); *SW of Boulder,* 1 (CU); *Horse Mesa, S of Boulder,* 1 (CU). GILPIN COUNTY: Dory Hill Pond, Blackhawk, 1 (ANSP). CLEAR CREEK COUNTY: Clear Creek, N side Idaho Springs, 1 (KU). JEFFERSON COUNTY: Semper, 1 (DMNH); *Olivet,* 10 (DMNH); Wheatridge, 2 (SC); *Morrison Road at Sheridan Boulevard,* 1 (UI); Morrison, 5 (SC). ADAMS COUNTY: Barr, 17 (11 DMNH, 5 UI, 1 WC); *Croak's [Croke] Lake,* 10 (DMNH); East Lake, 3 (DMNH); *Clear Creek,* 2 (DMNH); *Clear Creek at Washington Street,* 4 (DMNH); *South Platte River at Sand Creek,* 1 (DMNH); *N of Fitzsimmons on Sand Creek,* 1 (DMNH). DENVER COUNTY: Denver, 24 (3 AMNH, 2 USNM, 19 DMNH); *Sloan's Lake,* 1 (USNM); *Colfax Avenue at Sheridan Boulevard,* 1 (CU). ARAPAHOE COUNTY: 10 mi. E Denver, 1 (DMNH). PARK COUNTY: Jefferson, 2 (DMNH); 2 1/2 mi. S Estabrook, 6 (FHSC); Williams Ranch, near Tarryall, 11 (DMNH); 3 mi. SW Florissant, 1 (CU). DOUGLAS COUNTY: 9 mi. S, 12 mi. W Waterton, 2 (FHSC). TELLER COUNTY: Divide, 9200 ft., 2 (WC); [near] Cascade, 1 (UMMZ). EL PASO COUNTY: 2 mi. W Ramah, 5000 ft., 3 (KU); 2 mi. S Peyton, 6500 ft., 4 (UMMZ); 9 mi. N Colorado Springs, 7200 ft., 1 (CSU); Colorado Springs, 35 (4 AMNH, 5 MCZ, 26 WC).

Additional records: LARIMER COUNTY: *4 mi. SW Fort Collins* (Reed, 1957:135). WELD COUNTY: 1 mi. S, 6 mi. W Platteville (Archibold, 1964: 44). PARK COUNTY: Fairplay (Coues and Yarrow, 1875:106). EL PASO COUNTY: 12 mi. S Colorado Springs (Anderson, 1956:95).

Microtus montanus

MONTANE VOLE

Microtus montanus occurs widely in mountainous parts of western United States. In Colorado, the montane vole is sympatric with two other species of the genus, *M. longicaudus* and (to a lesser extent) *M. pennsylvanicus*. *Microtus montanus* is allopatric with the prairie vole. Cruzan (1968) studied interactions among the species of *Microtus* in the Front Range.

Typical habitat of the montane vole is moist meadows, but grassy sites well above standing water also are occupied. Runways and burrows frequently are encountered at the bases of aspens (*Populus tremuloides*). As a generalization, *M. montanus* has a broader range of ecological tolerance in Colorado than does *M. pennsylvanicus*, but has narrower limits than *M. longicaudus*. The altitudinal range of the montane vole is from about 6000 feet in major valleys of the Western Slope to well above timberline.

Geographic variation in *M. montanus* was discussed by Anderson (1954, 1959b); the arrangement of subspecies below generally follows those works. Findley and Jones (1962) provided detailed information on geographic distribution and variation in *M. montanus* in New Mexico and adjacent Colorado.

Microtus montanus fusus Hall

Microtus montanus fusus Hall, Proc. Biol. Soc. Washington, 51:133, 23 August 1938; type locality, 2 1/2 mi. E Cochetopa Pass, Saguache Co., Colorado.

Distribution in Colorado.—Mountains, high plateaus and mesas of southwestern part of state (Fig. 82).

Comparison.—From *M. m. nanus*, the subspecies geographically adjacent to the north, *M. m. fusus* differs in slightly paler, more reddish, more yellowish color, slightly narrower braincase, and smaller auditory bullae (after Anderson, 1954:494).

Measurements.—Mean (and extreme) external measurements of seven males from the Grand Mesa are: 163.6 (145-176), 42.1 (40-43), 18.7 (17-20), 14.7 (11-18); weight, 48.1 (38.1-60.5). Mean (and extremes) of three males and seven females from the San Juan Mountains and Mesa Verde are: 162.3 (155-167), 159.3 (155-166); 43.0 (38-47), 40.9 (38-47); 21.0 (20-23), 19.0 (18-20); 15.7 (15-17), 14.9 (14-16); weights of two males, 36.9, 50.0, mean of four females, 45.52 (38.2-54.0). Cranial measurements are presented in table 22.

Remarks.—The northern limits of the range of *M. m. fusus* in Colorado are roughly delimited by the valleys of the Colorado, Roaring Fork, and Arkansas rivers. Montane voles range southward into New Mexico in the San Juan Mountains, but are not known to occur in the Sangre de Cristo Range in either Colorado or New Mexico.

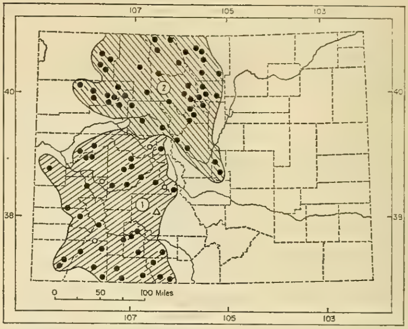


Fig. 82. Distribution of *Microtus montanus* in Colorado. 1. *M. m. fusus.* 2. *M. m. nanus.* For explanation of symbols, see p. 9.

As noted by Anderson (1959b:458), *M. m. fusus* is not sharply distinct from *M. m. nanus* in Colorado. Both species are highly variable, and samples from a broad area in central Colorado could be considered intergrades.

Specimens from Grand Mesa are notably less reddish than is usual for *M. m. fusus* from elsewhere in Colorado, but agree well with that subspecies in size and cranial proportions.

Records of occurrence.—Specimens examined, 239, distributed as follows: MESA COUNTY: 4 mi. S, 3 mi. E Collbran, 6800 ft., 1 (KU); Grand Mesa, 28 mi. E Grand Junction, 1 (KU); *9 mi. S Glade Park*, 1 (USNM); 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft., 1 (KU). LAKE COUNTY: 8 mi. SW Leadville, 10,000 ft., 5 (KU); *9 mi. SW Leadville*, 2 (KU). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 9600 ft., 7 (KU); 2 1/2 mi. S, 8 mi. E Skyway, 9600 ft., 1 (KU). GUNNISON COUNTY: Sylvanite Mine, 12,000 ft., 2 (ANSP); *2 mi. N Gothic*, 2 (KU); *Gothic, 9500 ft.*, 22 (2 ANSP, 1 KU, 6 UNM, 1 UMMZ, 12 USNM); *near Gothic, 10,500 ft.*, 1 (UMMZ); *Rocky Mountain Biological Laboratory*, 3 (USNM); *1 mi. S Gothic*, 1 (KU); Crested Butte, 11 (1 CSU, 1 MCZ, 9 WC); *Irwin, 10,700 ft.*, 3 (1 MCZ, 2 WC); near Beckwith Pass, 2 (1 KU, 1 UNM); Almont, 3 (USNM); Pitkin Fish Hatchery, 8200 ft., 1 (UMMZ); *Forest Reserve Camp, sec. 7, T. 49 N, R. 4 W, 8250 ft.*, 2 (WC); 10 mi. W Gunnison, 7500 ft., 2 (CSU);

8 mi. NW Sapinero, 9500 ft., 3 (USNM); *Black Mesa, 9 mi. WNW Sapinero, 9500 ft.,* 8 (KU); *no locality other than county,* 1 (ANSP). CHAFFEE COUNTY: 10 mi. SW Salida, 8500 ft., 2 (KU). MONTROSE COUNTY: Montrose, 1 (DMNH); Coventry, 7 (4 USNM, 3 WC); *Jackson Ranger Station, Uncompahgre National Forest* (not found), 1 (SC). OURAY COUNTY: Red Mountain Pass, 8 (SC). SAN MIGUEL COUNTY: Placerville, 1 (SC). SAGUACHE COUNTY: *2 mi. NE Cochetopa Pass, 10,000 ft.,* 1 (KU); *Cochetopa Pass, 10,000 ft.,* 7 (4 KU, 3 USNM); *Monshower Meadows, 3 mi. E Cochetopa Pass,* 14 (USNM); *5 mi. N, 28 mi. W Saguache, 9325 ft.,* 1 (KU); *5 mi. N, 26 mi. W Saguache, 9500-10,000 ft.,* 17 (KU); *5 mi. N, 24 mi. W Saguache, 9350 ft.,* 1 (KU). DOLORES COUNTY: sec. 13, T. 40 N, R. 13 W, 8100 ft., 1 (KU). HINSDALE COUNTY: Ruby Lake, 1 (USNM). MINERAL COUNTY: 3 mi. E Creede, 1 (KU); 4 mi. S, 4 mi. W Creede, 8800 ft., 1 (KU); *Wolf Creek Pass, 10,850 ft.,* 1 (UNM); 23 mi. S, 11 mi. E Creede, 9300 ft., 7 (KU). RIO GRANDE COUNTY: 8 mi. S, 11 mi. W Monte Vista, 1 (UI); *Blowout Pass [4 mi. N Jasper],* 1 (UI); *Windy Mountain, 11,000 ft.,* 1 (UI). MONTEZUMA COUNTY: 1 mi. W Mancos, 18 (KU); *Mancos,* 5 (SC); Upper Well, Prater Canyon, Mesa Verde National Park, 7575 ft., 11 (KU); *1/4 mi. N Middle Well, Prater Canyon, 7500 ft.,* 4 (KU). LA PLATA COUNTY: 21 mi. N Bayfield, 1 (AMNH); 8 mi. N, 2 mi. W Hesperus, 1 (UI); Florida, 6800 ft., 1 (KU); Allison, 2 (UNM). ARCHULETA COUNTY: 1/2 mi. N, 2 mi. E Chimney Rock, 3 (UNM); *1 mi. S, 1 1/4 mi. E Chimney Rock,* 2 (UNM); Navajo River, 6 (DMNH); NE 1/4, SW 1/4 sec. 17, T. 32 N, R. 4 W, 1 (UNM). CONEJOS COUNTY: Platoro, 21 (FHSC); *2 mi. E Platoro,* 1 (FHSC); *1 mi. SW Platoro,* 1 (FHSC); *"3-5 mi. SW Platoro,"* 3 (FHSC); La Manga Pass, 1 mi. S, 19 mi. W Antonito, 10,200 ft., 3 (KU); *4 mi. S, 24 mi. W Antonito, 9600 ft.,* 9 (KU); 12 mi. E Cumbres, 8800 ft., 5 (USNM).

Additional records (Anderson, 1954:503, unless otherwise noted): PITKIN COUNTY: 5 mi. W Independence Pass, 11,000 ft. LAKE COUNTY: *Independence Pass.* PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:36). GUNNISON COUNTY (Findley and Negus, 1953:236, unless otherwise noted): *East Maroon Pass, 4 2/10 mi. NE Gothic, 11,850 ft.; Copper Lake, 3 1/2 mi. NE Gothic, 11,110 ft.; Sylvanite Basin, 3 1/10 mi. NE Gothic, 11,500 ft.; East River, 6/10 mi. NW Gothic, 9600 ft.; Decker's Ranch, Crested Butte* (Anderson, 1954:503); *1 4/10 mi. up Steuben Creek from Gunnison River* (Durrant and Robinson, 1962:252); *Monarch Pass* (Anderson, 1959b:483); *1 1/2 mi. E East Elk Creek, 7560 ft.* (Durrant and Robinson, 1962:252); *E of Red Creek on Gunnison River, 7355 ft.* (Durrant and Robinson, *loc. cit.*); *Cebolla Creek, 2 mi. up from Gunnison River, 7400 ft.* (Durrant and Robinson, *loc. cit.*). MONTROSE COUNTY: near Maher (Warren, 1929:82). SAGUACHE COUNTY: 2 1/2 mi. E Cochetopa Pass (Hall, 1938:131). LA PLATA COUNTY: Columbine Ranger Station, 8700 ft., Cascade Creek (Hall, *loc. cit.*). ARCHULETA COUNTY: *Osier* (Anderson, 1959b:483); Sambrito Creek, 1/2 mi. N New Mexico boundary (Durrant and Dean, 1961:175).

Microtus montanus nanus (Merriam)

Arvicola (Mynomes) nanus Merriam, N. Amer. Fauna, 5:63, 30 July 1891; type locality, Pahsimeroi River, Pahsimeroi Mountains, 9350 ft., Custer Co., Idaho.

Microtus montanus nanus, Hall, Proc. Biol. Soc. Washington, 51:133, 23 August 1938.

Distribution in Colorado.—Mountains and high plateaus of northwestern and north-central parts of state (Fig. 82).

Comparison.—For comparison with *M. m. fusus,* see account of that subspecies.

Measurements.—Mean (and extreme) external measurements of six males, followed by those of 10 females, all from Larimer County and immediately adjacent Albany County, Wyoming, are: 170.2 (160-182), 164.3 (156-180); 45.7 (37-62), 42.2 (38-49); 19.0 (18-21), 18.9 (16-20); 13.0 (12-16), 12.7 (9-14); weights, 49.53 (40.0-55.0), 41.85 (36.4-45.0). Selected cranial measurements are presented in table 22.

Records of occurrence.—Specimens examined, 220, distributed as follows: MOFFAT COUNTY: 14 mi. NW Craig, 2 (CSU); 8 mi. ENE Craig, 6 (CM); *about 8 mi. ENE Craig,* 6 (CM); Lay, 2 (WC); 9 mi. SW Craig, 1 (CM); 9 mi. S Craig, 1 (CM). ROUTT COUNTY: Steamboat Springs, 3 (WC); Wright's Ranch, near Yampa, 7700 ft., 3 (WC); 8 mi. E Toponas, 8000 ft., 3 (USNM). JACKSON COUNTY: WyoColo, 2 (CSU); near Pearl, 1 (CSU); Boettcher Ranch, near Lake John, 1 (DMNH); 3 mi. below Cameron Pass, 2 (WC); *2 mi. N, 2 mi. E Gould, 8600 ft.,* 2 (KU); *Homestead Ranch,* 1 (DMNH); Arapaho Pass, 2 (USNM). LARIMER COUNTY: *1 mi. S Red Feather Lakes,* 1 (CSU); Parvin Lake, 8000 ft., 1 (CSU); *1 mi. S, 20 mi. W Livermore, 8400 ft.,* 2 (KU); *Log Cabin,* 1 (CSU); 4 mi. S, 14 mi. W Livermore, 7500 ft., 1 (KU); *Sevenmile Creek, 46 mi. NW Fort Collins,* 2 (CSU); Rawah Lake No. 3, 10,500 ft., 2 (CSU); *Rawah Primitive Area, 10,000 ft.,* 1 (CSU); *1 mi. S, 11 mi. W Rustic,* 2 (KU); *1 1/2 mi. S, 12 1/2 mi. W Rustic,* 3 (KU); *Cache la Poudre River,* 1 (FMNH); 1/2 mi. E Pennock Pass, 8680 ft., 1 (CSU); *South Fork Cache la Poudre River, T. 7 N, R. 73 W,* 3 (UNM); *3 mi. N, 3 mi. E Estes Park,* 4 (FHSC); *9 mi. WNW Estes Park,* 4 (FHSC); *16 mi. W Loveland,* 1 (KU); *2 1/2 mi. N, 4 mi. W Estes Park,* 4 (FHSC); 1/2 mi. S, 6 mi. W Loveland, 5200 ft., 1 (KU); Estes Park, 1 (USNM); *2 mi. E Estes Park,* 1 (CSU); *2 1/2 mi. S, 19 1/2* *mi. W Loveland, 7280 ft.*, 6 (KU); Moraine Park, 1 (RMNP); *3 mi. S, 3 mi. W Estes Park*, 5 (KU). RIO BLANCO COUNTY: 18 mi. NW Meeker, 5800 ft., 1 (CSU); 5 mi. S Pagoda Peak, 9100 ft., 3 (KU); Meeker, 1 (USNM); Buford, 1 (CU); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 5 (CM); Dry Fork, White River, 6200 ft., 18 (AMNH); 8 mi. SE South Fork Campground, White River National Forest, 10,860 ft., 3 (CSU). GARFIELD COUNTY: Trappers Lake, 9600 ft., 1 (CSU); Deep Lake, 16 mi. N Glenwood Springs, 3 (KU). EAGLE COUNTY: 20 mi. SW Toponas, 1 (DMNH); [near] Eagle, about 10,000 ft., 1 (USNM); Pando, 2 (USNM); *Camp Hale, 10,000 ft.*, 2 (CU). GRAND COUNTY: *Mount Whiteley*, 2 (USNM); 2 1/2 mi. S, 2 mi. W Grand Lake, 8368 ft., 1 (UNM); *5 1/2 mi. S, 3 1/2 mi. W Grand Lake*, 6 (UNM); Coulter, 4 (USNM); Corona, 1 (CU); camp near Sheephorn Pass, 8200 ft., 1 (WC); Berthoud Pass, 3 (FWS). BOULDER COUNTY: 3/4 mi. N, 2 mi. W Allenspark, 5 (KU); *Niwot Ridge*, 1 (CU); 3 mi. S Ward, 9000 ft., 1 (KU); Boulder, 2 (FMNH); *Nederland*, 33 (FMNH); Eldora, 1 (FMNH); *Dixie Lake*, 3 (DMNH). GILPIN COUNTY: Tolland, 2 (CU); *Lump Gulch*, 5 (CU); *Moon Gulch, 2 1/2 mi. SW Rollinsville*, 3 (CU). CLEAR CREEK COUNTY: *Berthoud Pass*, 4 (KU); Silverplume, 1 (SC); *Mount McClellan, 11,000 ft.*, 2 (USNM); Gray's Peak, 4 (KU); *Hermann Gulch, 10,500 ft.* (not found), 2 (SC). PARK COUNTY: *Mount Bross*, 1 (DMNH); Alma, 1 (CSU); *Buckskin Gulch, 1 mi. above Alma, 10,500 ft.*, 2 (WC); Trout Creek Ranch, 2 mi. N Garo, 1 (CSU). TELLER COUNTY: Florissant, 1 (CSU); 1 mi. N Gillet, 1 (UNM). EL PASO COUNTY: 2 mi. S Peyton, 6500 ft., 1 (UMMZ).

Additional records: GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). GILPIN COUNTY: *Jumbo Mountain* (Williams and Finney, 1967:74). TELLER COUNTY: *Twin River* (V. Bailey, 1900:31).

Microtus longicaudus

LONG-TAILED VOLE

The long-tailed vole occurs widely in the western United States and adjacent Canada, reaching the eastern limit of its range in the Black Hills and the mountains of Colorado. *Microtus longicaudus* is the most euryecious of Coloradan microtines and has a wide altitudinal range, from below 5000 feet in the Grand Valley of the Colorado to well above timberline.

The species ranges lower on the Western Slope than it does in the east. The effect of other species of *Microtus* in determining the eastern limits of the range has not been specifically documented, although Cruzan (1968) studied ecological relationships of species of *Microtus* in the vicinity of Boulder.

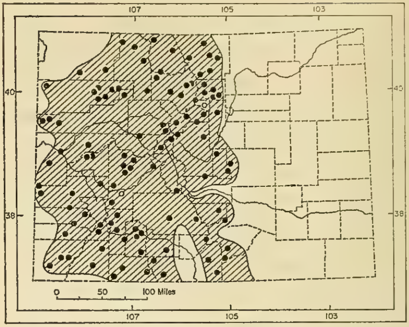


FIG. 83. Distribution of *Microtus longicaudus longicaudus* in Colorado. For explanation of symbols, see p. 9.

A wide variety of habitats is utilized. These animals are perhaps most abundant in stream-side meadows, but there is less dependence on grass tunnels than in other Coloradan species of *Microtus*, and the long-tailed vole may occur in forested areas with minimal grass-cover. Durrant and Robinson (1962: 252) reported the species as common in the brushy meadows on sandy soil along the Lake Fork of the Gunnison.

Microtus longicaudus longicaudus (Merriam)

Arvicola (Mynomes) longicaudus Merriam, Amer. Nat., 22:934, October 1888; type locality, Custer, 5500 ft., Custer Co., South Dakota.

Microtus (Mynomes) longicaudus, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:266, 21 August 1895.

Distribution in Colorado.—Mountains and plateaus of western three-fifths of state (Fig. 83).

Measurements.—Average and extreme external measurements of three males from Huerfano County, three males from Larimer and Boulder counties, and four males from Rio Blanco and Garfield counties, are, respectively: 177.7 (176-179), 187.7 (183-195), 187.2 (174-196); 60.3 (59-62), 63.7 (61-65), 64.2 (53-66); 21.0 (20-22), 21.3 (20-22), 20.8 (20-21); 16.3 (16-17), 15.0 (13-17), 14.5 (14-15); weight, 47.50 (46.0-49.5), 44.67 (40.0-

49.4), 50.25 (43.1-56.6). For cranial measurements, see table 22.

Remarks.—Individual variation of cranial features with age is marked in long-tailed voles, as is typical of microtines in general. The color of pelage of Coloradan specimens varies considerably with season, and when worn is quite pale. When specimens in comparable pelage are considered, individual variation in color is minimal, and no geographic trends are apparent.

Long-tailed voles in Colorado were considered for many years to represent the subspecies *M. l. mordax,* a taxon described by Merriam (1891:61) on the basis of material from the Sawtooth Mountains of Idaho. V. Bailey (1900:49) pointed out the close similarity of *mordax* and *longicaudus,* but regarded the two as distinct species; *longicaudus* was known to him by only six specimens. Goldman (1938a:491) arranged *mordax* as a subspecies of *longicaudus.*

Long (1965:655) noted that, although long-tailed voles of the Black Hills are isolated to some (unknown) degree from those of the mountains to the west and southwest in Wyoming, specimens from the two areas are indistinguishable morphologically. I have compared specimens from the Bighorn Mountains, Wyoming, with individuals from Lawrence and Pennington counties, South Dakota, and concur with Long (*loc. cit.*) that differences between the two populations are insufficient to warrant their separation as distinct subspecies. Furthermore, comparison of material from Rio Blanco and Larimer counties, Colorado, with the above-mentioned specimens from Wyoming and South Dakota has convinced me that these too are indistinguishable and that Coloradan long-tailed voles should be known as *M. l. longicaudus.* Whether *mordax* is, in fact, a synonym of *longicaudus* is a question that best awaits consideration of geographic variation over the entire range of *M. longicaudus.*

Elliot (1907:298) referred a single specimen from Florida, La Plata County, to the subspecies *alticola.* In my judgement, all Coloradan long-tailed voles represent a single subspecies. Durrant and Robinson (1962:253) reached that same conclusion.

Records of occurrence.—Specimens examined, 625, distributed as follows: MOFFAT COUNTY: 9 mi. SW Craig, 2 (CM); 5 mi. SE Cross Mountain, 3 (CM). ROUTT COUNTY: Elkhead Mountains, 20 mi. SE Slater, 3 (USNM); Hahn's Peak, 2 (USNM); 5 mi. N Steamboat Springs, 1 (DMNH); Gore Range, 8 mi. E Toponas, 8000 ft., 1 (USNM). JACKSON COUNTY: Pearl, 2 (USNM); *near Pearl,* 1 (CSU); Canadian Creek, 1 (USNM); Arapaho Pass, 4 (USNM). LARIMER COUNTY: 25 mi. NW Fort Collins, 3 (CSU); *5 1/2 mi. S Indian Meadows, 7800 ft.,* 6 (CSU); *8 mi. N, 15 mi. W Fort Collins,* 1 (UI); *Poudre Canyon,* 1 (DMNH); *Bennett Creek, 7600 ft.,* 5 (2 CSC, 3 CSU); *3 1/2 mi. N, 12 1/2 mi. W Fort Collins,* 4 (CSU); Rist Canyon, 10 mi. NW Fort Collins, 1 (CSU); Chambers Lake, 9500 ft., 4 (CSU); 6 mi. W Fort Collins, 6500 ft., 1 (CSU); *South Fork Cache la Poudre River, T. 7 N, R. 73 W,* 1 (UNM); *3 mi. S, 10 mi. W Fort Collins,* 1 (CSU); 16 mi. W Loveland, 6840 ft., 2 (KU); *Upper Hidden Valley,* 1 (RMNP); *Estes Park,* 2 (USNM); *2 1/2 mi. S, 19 1/2 mi. W Loveland, 7280 ft.,* 1 (KU); *Moraine Park,* 2 (RMNP); 3 mi. S, 3 mi. W Estes Park, 7700 ft., 5 (4 KU, 1 UI); *Bear Lake, 9485 ft.,* 2 (DMNH); *Longs Peak, at timberline,* 10 (USNM). RIO BLANCO COUNTY: 5 mi. W Rangely, 5600 ft., 2 (USNM); 7 mi. NE Meeker, 22 (CM); 5 mi. S Pagoda Peak, 9100 ft., 1 (KU); 9 1/2 mi. SW Pagoda Peak, 7700 ft., 30 (KU); *6 mi. NE Meeker,* 4 (CM); Meeker, 2 (USNM); *Marvine Lodge,* 1 (CU); *Lost Creek, 9 mi. NE Buford,* 9 (CM); *Dry Fork, White River, 6200 ft.,* 6 (AMNH); *between Flag Creek and Grand Hogback, 9 mi. S Meeker,* 7 (CM); 15 mi. SE Meeker, 9 (CM). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 7 (CM); West Fork Douglas Creek, 8000 ft., 2 (CM); *28 mi. N, 5 1/2 mi. W Mack, 7250 ft.,* 3 (KU); *28 mi. N, 5 mi. W Mack, 7250 ft.,* 1 (KU); Baxter Pass, Book Plateau, 8500 ft., 1 (USNM); head Douglas Creek, 7 (CM). EAGLE COUNTY: Camp Hale, 8 (CU); 10 mi. N, 1 mi. W Leadville, 1 (KU). GRAND COUNTY: Mount Whiteley, 2 (USNM); *Grand Lake, 8300 ft.,* 1 (WC); 3 mi. S, 2 mi. W Grand Lake, 8375 ft., 2 (UNM); Cache River, 4 mi. N Stillwater, 3 (UI); Hot Sulphur Springs, 5 (2 USNM, 3 WC); *4 mi. SW Hot Sulphur Springs,* 1 (CU); Coulter, 1 (USNM). SUMMIT COUNTY: 1 mi. SE Frisco, 9100 ft., 1 (UI); Hoosier Pass, 4 (DMNH). BOULDER COUNTY: 12 1/2 mi. S Estes Park, 8400 ft., 1 (KU); *3/4 mi. N, 2 mi. W Allenspark, 8400 ft.,* 10 (KU); Gold Hill, 2 (USNM); Ward, 9500 ft., 4 (USNM); *Niwot Ridge,* 1 (CU); *Silver Lake,* 1 (DMNH); *Science Lodge,* 1 (CU); *3 mi. S Ward, 9000 ft.,* 10 (KU); *3 mi. S, 1/2 mi. E Ward, 9400 ft.,* 2 (KU); *6 mi. NW Nederland,* 1 (CU); *5 mi. W Boulder,* 1 (CU); *4 1/2 mi. N, 1 mi. W Nederland,* 1 (FHSC); *4 mi. N, 1 mi. W Nederland,* 1 (CU); *Magnolia,* 2 (CU); Gregory Canyon, 1 (CU); *Nederland,* 1 (USNM); *Eldora,* 4 (CU); 3 mi. E Pinecliff, 4 (DMNH); Dixie Lake, 1 (DMNH); *Coal Creek,* 1 (DMNH); *no locality other than county,* 2 (USNM). CLEAR CREEK COUNTY:

Clear Creek, N side Idaho Springs, 1 (KU); *Camp Lemon, 5 mi. above Silverplume,* 1 (DMNH); Graymount, 2 (SC); *Mount Kelso, above timberline, 11,800 ft.,* 2 (USNM); *Mount McClellan, 11,000 ft.,* 2 (USNM); Loveland Pass, 1 (KU); *Hermann Gulch* (not found), 2 (SC). JEFFERSON COUNTY: foothills [near] Golden, 7300 ft., 3 (USNM). MESA COUNTY: 4 mi. S, 3 mi. E Collbran, 6800 ft., 2 (KU); Grand Junction, 2 (1 FMNH, 1 WC); *9 mi. S Glade Park,* 4 (1 AMNH, 3 CM); 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft., 1 (KU). PITKIN COUNTY: Thomasville, 1 (CU). LAKE COUNTY: Mount Bross, 11,800 ft., 2 (DMNH); 8 mi. SW Leadville, 1 (KU). PARK COUNTY: 8 mi. NNE Grant, 10,000 ft., 1 (FWS); 2 1/2 mi. S Estabrook, 2 (FHSC); *Buckskin Creek, above Alma,* 1 (WC); *Levic* (not found), 1 (DMNH). DELTA COUNTY: 12 mi. S, 5 1/2 mi. E Collbran, 10,200 ft., 3 (KU); *1 mi. S, 8 mi. E Skyway, 10,200 ft.,* 1 (KU); *1 1/2 mi. S, 8 mi. E Skyway, 10,200 ft.,* 2 (KU); *2 mi. S, 8 mi. E Skyway, 10,200 ft.,* 1 (KU); 2 1/2 mi. S, 8 mi. E Skyway, 9600 ft., 1 (KU). GUNNISON COUNTY: Marble, 1 (DMNH); Copper Lake, 10,500 ft., 4 (2 KU, 1 UNM, 1 USNM); *Quigley Creek, 10,300 ft., Gothic Natural Area,* 1 (UMMZ); *Gothic,* 20 (2 KU, 9 UNM, 9 USNM); *Rocky Mountain Biological Laboratory,* 6 (USNM); Taylor Park, 2 (DMNH); Irwin, 10,700 ft., 4 (1 AMNH, 1 MCZ, 2 WC); Crested Butte, 4 (1 AMNH, 1 CSU, 1 MCZ, 1 WC); *Decker's Ranch, near Crested Butte,* 3 (AMNH); Carbon Peak, 1 (WSC); *7 1/2 mi. W Gunnison,* 2 (FHSC); *9 mi. WNW Sapinero, 9500 ft.,* 1 (KU); Forest Reserve Camp, sec. 7, T. 49 N, R. 4 W, 8250 ft., 2 (WC); 33 mi. SW Sapinero, 2 (CM). CHAFFEE COUNTY: 10 mi. SW Salida, 24 (KU). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 1 (FWS); *7 mi. NNE Florissant, 8900 ft.,* 5 (FWS); Divide, 2 (WC). EL PASO COUNTY: *Cascade,* 1 (USNM); *Glen Cove, Pikes Peak, 11,350 ft.,* 4 (UMMZ); *Halfway,* 1 (UMMZ); Bear Creek, 6500 ft., 1 (WC); *Bear Creek, 7600 ft.,* 1 (WC); Lake Moraine, 1 (AMNH); *no locality other than county,* 1 (MCZ). MONTROSE COUNTY: Black Canyon of the Gunnison National Monument, 3 (CU); SW 1/4 sec. 11, T. 48 N, R. 14 W, 9000 ft., 5 (KU); La Sal Mountains, 1 (DMNH); West Paradox Valley, 6 (DMNH); Coventry, 1 (WC); *Jackson Ranger Station, Uncompahgre National Forest* (not found), 1 (SC). OURAY COUNTY: Red Mountain Pass, 10 (SC). SAN MIGUEL COUNTY: Placerville, 1 (SC). SAGUACHE COUNTY: 11 mi. SW Saguache, 1 (DMNH); *2 mi. N, 2 mi. E Crestone, 8300 ft.,* 2 (KU); *2 mi. N, 2 1/2 mi. E Crestone, 8500 ft.,* 14 (KU); Crestone, 5 (WC). FREMONT COUNTY: 5 1/2 mi. SE Guffey, 1 (CU). CUSTER COUNTY: 1 1/2 mi. N, 1 1/2 mi. W Fairview, 13 (KU); 1 1/2 mi. SW San Isabel City, 9000 ft., 1 (KU). DOLORES COUNTY: Lone Cone, 1 (SC); 15 mi. N, 10 mi. E Dolores, 8250 ft., 2 (KU). SAN JUAN COUNTY: Silverton, 5 (USNM). HINSDALE COUNTY: Lake City, 2 (USNM); 7 mi. S, 2 mi. W Lake City, 9000 ft., 1 (KU); Hermit, 2 (USNM); Ruby Lake, 1 (USNM). MINERAL COUNTY: Wasson Ranch, Creede, 1 (KU); *4 mi. S, 4 mi. W Creede, 8800 ft.,* 1 (KU); Wagon Wheel Gap, 5 (1 MCZ, 4 WC); 4 mi. S, 6 mi. W Wagon Wheel Gap, 8500 ft., 1 (KU); 22 mi. S, 12 mi. E Creede, 8630 ft., 1 (KU). RIO GRANDE COUNTY: 8 mi. S, 11 mi. W Monte Vista, 7 (UI). ALAMOSA COUNTY: 1/2 mi. S Uracca [Verracca] Pioneer Cemetery, 2 (KU). HUERFANO COUNTY: La Veta, 1 (UMMZ); *4 mi. S La Veta, 7000 ft.,* 1 (KU); 5 mi. S, 1 mi. W Cucharas Camps, 21 (KU). MONTEZUMA COUNTY: Mancos, 1 (SC); N end Mesa Verde National Park, 7000 ft., 5 (KU); *Upper Well, Prater Canyon, 7575 ft.,* 1 (KU); *Prater Canyon, 7600 ft.,* 7 (KU); *Morfield Canyon, 7600 ft.,* 16 (KU); *W bank Mancos River,* 1 (KU); Ute Peak, 3 (DMNH). LA PLATA COUNTY: 21 mi. N Bayfield, 2 (AMNH); Florida, 11 (10 AMNH, 1 FMNH). ARCHULETA COUNTY: Devil's Creek, near Dyke, 1 (DMNH); headwaters, Navajo River, 2 (DMNH); *4/10 mi. S junction, Colorado Highway 151 and U. S. Highway 160,* 4 (UNM); *1 mi. S, 1 1/4 mi. E Chimney Rock,* 3 (UNM); *mouth of Archuleta Cañon,* 1 (UNM); Stollsteimer Creek, near mouth of Archuleta Cañon, 1 (UNM); *Stollsteimer Creek, near mouth of Deep Cañon,* 1 (UNM); *Upper Navajo River,* 1 (DMNH); *Deep Cañon, 4 mi. S, 2 mi. W Chimney Rock,* 16 (UNM); *NE 1/4, SE 1/4 sec. 18, T. 32 N, R. 4 W,* 1 (UNM); *NW 1/4 sec. 23, T. 32 N, R. 6 W,* 2 (UNM); *no locality other than county,* 2 (DMNH). CONEJOS COUNTY: *1/2 mi. N, 1 mi. W Platoro, 9500 ft.,* 2 (KU); Platoro, 2 (FHSC); *1 mi. SW Platoro,* 3 (FHSC); *"3-5 mi. SW Platoro,"* 23 (FHSC); *12 mi. NE Cumbres,* 1 (AMNH); *Trujillo Meadows Reservoir, 1 mi. S, 24 mi. W Antonito, about 10,200 ft.,* 1 (UNM); La Manga Pass, 1 mi. S, 19 mi. W Antonito, 10,200 ft., 1 (KU); *4 mi. S, 23 mi. W Antonito,* 3 (KU); *5 mi. S, 25 mi. W Antonito, 9600 ft.,* 1 (KU); *5 mi. S, 23 mi. W Antonito,* 2 (KU). COSTILLA COUNTY: *Fort Garland,* 12 (1 FWS, 11 USNM); 5 mi. SSE Fort Garland, 1 (AMNH); Culebra Cañon, 9000 ft., 2 (WC). County unknown: *Indian Creek Park,* 1 (DMNH); *Arrowhead,* 1 (USNM).

Additional records: GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). BOULDER COUNTY: *near Science Lodge, about 10,000 ft.* (Williams and Finney, 1964:265). GILPIN COUNTY: Jumbo Mountain (Williams and Finney, 1967:74); *Moon Gulch* (Williams, 1955b: 224). GUNNISON COUNTY (Durrant and Robinson, 1962:253, unless otherwise noted): *Copper Lake Basin, 3 7/10 mi. NE Gothic, 11,200 ft.* (Findley and Negus, 1953:237); *2 mi. NW Gothic, 10,200 ft.* (Findley and Negus, *loc. cit.*); *East River, 6/10 mi. NW Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *1 mi. SE Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *1 4/10 mi. up Steuben Creek from Gunnison River, 7440 ft.; Dry Gulch, 2 mi. above Gunnison River, 7600 ft.; 1/2 mi. N mouth of Willow Creek, 7600 ft.; Soap Creek, 1/4 mi. N Gunnison River; West Elk Creek, 1/4 mi. N Gunnison River,* *7400 ft.; Willow Creek, 1/4 mi. N Gunnison River, 7600 ft.; near junction Red Creek and Gunnison River, 7350 ft.; 1/2 mi. W junction Meyers' Gulch and Gunnison River, 6975 ft.; 1 mi. up Lake Fork, 7290 ft.; 2 mi. up Lake Fork, 7295 ft.;* 5 1/2 mi. up Lake Fork, 7400 ft.

Microtus mexicanus

MEXICAN VOLE

Microtus mexicanus was first reported from Colorado by Rodeck and Anderson (1956). To date, all records of occurrence in Colorado are from Mesa Verde National Park. Typical habitat of the species is grassy areas in woodlands of *Pinus ponderosa.* According to Anderson (1961:55), the Mexican vole inhabits drier, more open sites on Mesa Verde than does *Microtus montanus,* and sites with less cover than are utilized by *Microtus longicaudus.*

Microtus mexicanus mogollonensis (Mearns)

Arvicola mogollonensis Mearns, Bull. Amer. Mus. Nat. Hist., 2:283, 21 February 1890; type locality, Baker's Butte, Mogollon Mountains, Coconino Co., Arizona.

Microtus mexicanus mogollensis, V. Bailey, N. Amer. Fauna, 53:204, 1 March 1932.

Distribution in Colorado.—Known at present only from Mesa Verde, Montezuma County (Fig. 84).

Measurements.—External measurements of an adult male, two young adult males, and two young adult females from Mesa Verde are: 152, 141, 145, 145, 143; 33, 28, 34, 30, 28; 21, 20, 18, 20, 18; 14, 14, 14, 13, 16; a female weighed 30.7. Cranial measurements are presented in table 22.

Remarks.—Specimens of *M. mexicanus* from Colorado agree well in external and cranial details with undoubted *mogollonensis* from Coconino County, Arizona. I have not examined specimens of *M. m. navaho,* presently known only from Navajo Mountain, San Juan Co., Utah. Judging from the description of that subspecies (Benson, 1934:49), animals from Utah are considerably paler than those from Mesa Verde, or elsewhere in the range of *M. mexicanus.*

Records of occurrence.—Specimens examined, 25, distributed as follows: MONTEZUMA COUNTY: Prater Canyon, 7600 ft., Mesa Verde National Park, 5 (KU); *sec. 27, head East Fork Navajo Canyon, 7900 ft.,* 1 (KU); *Far View Ruins, 7700 ft.,* 3 (KU); *1 2/10 mi. S Far View Road,* 1 (KU); *2 mi. NNW Rock Springs, 7900 ft.,* 3 (KU); *Park Well, 7450 ft.,* 7 (KU); *Park Headquarters, 7000 ft.,* 4 (KU); *head of Spruce Tree Canyon, 7000 ft.,* 1 (DMNH).

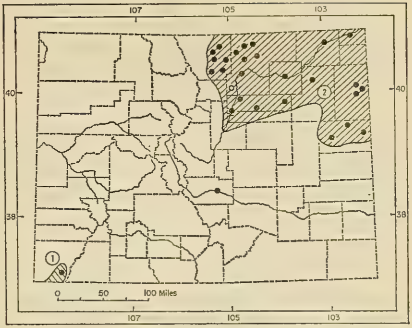


FIG. 84. Distribution of two species of microtine rodents in Colorado. 1. *Microtus mexicanus mogollonensis.* 2. *Microtus ochrogaster haydenii.* For explanation of symbols, see p. 9.

Microtus ochrogaster

PRAIRIE VOLE

Microtus ochrogaster is an inhabitant of the central grasslands of North America. The distribution is dendritic along streams in much of northeastern Colorado, but in irrigated areas occurrence is more general. The western limit of the species is marked by the foothills of the Front Range, although suitable habitat in the lower canyons of some mountain streams is occupied. The natural history of the prairie vole in Colorado was discussed briefly by Burnett (1930b). Cruzan (1968) studied ecological distribution of species of *Microtus* in Boulder County. Interaction of *M. ochrogaster* with other species of *Microtus* in Colorado is minimal, because the range of the prairie vole and those of its congeners are nearly mutually exclusive. The exception is *M. pennsylvanicus,* which is sympatric with *M. ochrogaster* in parts of the South Platte and Republican drainages. The relationship between these two species east of the Front Range has not been studied.

The influence of irrigation on the distribution in Colorado of *M. ochrogaster* is not known, but probably irrigation has allowed local expansion in areas already occupied. In general, the habitat in eastern Colorado must be more favorable for the species today than in the past, and less subject to fluctuation.

Microtus ochrogaster haydenii (Baird)

Arvicola (Pedomys) haydenii Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):543, 14 July 1858; type locality, Fort Pierre, Stanley Co., South Dakota.

Microtus ochrogaster haydeni, Osgood, Proc. Biol. Soc. Washington, 20:48, 18 April 1907.

Distribution in Colorado.—Drainages of South Platte and Republican rivers, northeastern part of state (Fig. 84).

Comparison.—From *M. o. taylori,* the subspecies of the Arkansas River Valley in southwestern Kansas, *M. o. haydenii* differs in slightly longer, broader skull, less pronounced interorbital ridge, and grayish brown (rather than snuff brown) dorsal pelage (after Cockrum, 1952:205).

Measurements.—Mean (and extreme) external measurements of six males, followed by those of five females, from the vicinity of Loveland, Larimer County, are: 175.6 (162-188), 175.2 (168-182); 45.2 (41-53), 45.0 (41-50); 21.5 (20-23), 21.5 (20-22); 12.8 (12-15), 12.8 (12-14); mean weight of six males, 60.0 (54-71), of four females, 59.2 (58-68). Representative cranial measurements are given in table 22.

Remarks.—A single specimen of *M. ochrogaster* has been reported from the Arkansas River Valley in Colorado, that being a young adult female (USNM 35669) from Cañon City. The specimen was obtained in October 1892 by J. A. Loring. Since that date, a number of collectors have worked at various localities in the Arkansas Valley, but *M. ochrogaster* has not been obtained. A record of the prairie vole from that part of the state is intriguing. A local population of *Geomys bursarius,* the plains pocket gopher, apparently is isolated in the vicinity of Cañon City within the range of *Thomomys bottae,* and the few available specimens suggest the formation of a local race there. Preliminary evidence suggests the possibility of a relict enclave of prairie species in the Cañon City area. At any rate, the possibility would seem worthy of investigation.

The available specimen of *M. ochrogaster* from the Arkansas Valley is paler in color than specimens of *M. o. taylori* from southwestern Kansas, but more yellowish and less grayish than material from northeastern Colorado. In cranial details, the individual agrees better with a series of *haydenii* from Larimer County, to which subspecies it is tentatively referred.

It is highly probable that the prairie vole occurs along the Arkansas River in extreme eastern Colorado. *Microtus o. taylori* has been reported from Coolidge, Hamilton Co., Kansas (Cockrum, 1952:205); that locality is about six miles to the east of Holly, Colorado.

Records of occurrence.—Specimens examined, 379, distributed as follows: LARIMER COUNTY: 1/2 mi. N, 1/4 mi. E Livermore, 1 (CSU); *sec. 27, T. 10 N, R. 70 W,* 1 (CSU); *Owl Canyon,* 1 (CSU); *10 mi. N Fort Collins, 5200 ft.,* 3 (CSU); 8 mi. N, 15 mi. W Fort Collins, 2 (UI); *6 mi. N, 2 mi. W Fort Collins, 5100 ft.,* 1 (CSU); *3 mi. N, 2 mi. W Laporte, 5100 ft.,* 2 (CSU); *9/10 mi. E Ted's Place,* 1 (CSU); *7 1/2 mi. NW Fort Collins,* 1 (CSU); *5 mi. N, 1 mi. W Fort Collins,* 2 (CU); *5 mi. N Fort Collins,* 4 (1 CSU, 3 CU); *6 1/2 mi. NW Fort Collins,* 1 (CSU); *4 mi. N Fort Collins,* 1 (CSU); *4 mi. N, 2 mi. E Fort Collins,* 1 (CSU); *1/2 mi. NE Bellvue, 5200 ft.,* 1 (CSC); *Watson Lake, 1/4 mi. NE Bellvue,* 9 (2 CSC, 7 CSU); *4 1/2 mi. NW Fort Collins,* 5 (CU); *1/2 mi. N, 3 mi. W Buckhorn [Masonville?],* 1 (CSU); *Rist Canyon,* 4 (CSU); *Poudre River, 1 mi. W Bellvue,* 1 (CSU); *3/4 mi. E Bellvue,* 2 (CSU); *3 mi. N, 3 mi. E Fort Collins,* 1 (CSU); *4 mi. NW Fort Collins,* 1 (CU); *1/4 mi. SE Bellvue,* 1 (CSU); *9/10 mi. S, 6/10 mi. W Bellvue,* 2 (CU); *SE 1/4 sec. 36, T. 8 N, R. 70 W,* 2 (CSU); *sec. 6, T. 7 N, R. 70 W, 5200 ft.,* 1 (CSU); *1/4 mi. N Horsetooth Reservoir,* 1 (CU); *2 1/2 mi. NE Fort Collins,* 1 (CSU); *N end Horsetooth Reservoir,* 1 (CSU); *2 mi. NW Fort Collins, 5200 ft.,* 2 (CSU); *1 mi. N, 5 1/2 mi. W Fort Collins,* 1 (CSU); *1 mi. N, 4 mi. W Fort Collins, 5100 ft.,* 8 (6 CSU, 2 CU); *1 mi. N Fort Collins,* 1 (CSU); *NW of Fort Collins,* 1 (CU); *1/2 mi. N, 1/2 mi. E Poudre Valley Memorial Hospital, Fort Collins,* 2 (CU); 10 mi. W Fort Collins, 1 (CSU); *5 mi. W Fort Collins,* 1 (CSU); *4 mi. W Fort Collins,* 3 (CSU); *3 1/2 mi. W Fort Collins,* 1 (CSU); *3 mi. W Fort Collins,* 5 (CSU); *2 mi. W Fort Collins,* 7 (CSU); Fort Collins, 15 (9 CSU, 2 CU, 4 USNM); *1/8 mi. E Fort Collins,* 1 (CSU); *1/2 mi. E Fort Collins,* 3 (CSU); *3/4 mi. E Fort Collins,* 1 (CSU); *1 mi. E Fort Collins,* 2 (CSU); *2 mi. E Fort Collins,* 1 (CU); *3 4/10 mi. E Fort Collins,* 1 (CSU); *4 mi. E Fort Collins,* 2 (CSU); *1/2 mi. S, 1 mi. E Fort Collins,* 3 (CU); *1 mi. S, 4 mi. W Fort Collins,* 1 (CSU); *1 mi. S, 3 1/2 mi. W Fort Collins,* 5 (CSU); *1 mi. S, 3 1/2 mi. E Fort Collins,* 2 (CU); *Horsetooth Dam,* 7 (CSU); *1 1/2 mi. SW Fort Collins,* 2 (CU); *1 3/4 mi. S Fort Collins,* 1

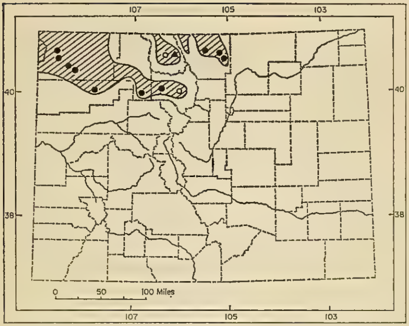


FIG. 85. Distribution of *Lagurus curtatus levidensis* in Colorado. For explanation of symbols, see p. 9.

(CSU); *2 mi. S, 4 mi. W Fort Collins,* 2 (CSU); *2 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *2 mi. S, 3 mi. E Fort Collins,* 1 (CSU); *Dixon Dam,* 1 (CSU); *Dixon Lake,* 1 (CSU); *1 1/2 mi. NE Spring Canyon Dam, 5120 ft.,* 2 (CSU); *3 mi. S, 10 mi. W Fort Collins,* 1 (CSU); *3 mi. S, 2 mi. W Fort Collins,* 1 (CSU); *4 mi. SE Fort Collins, 4800 ft.,* 1 (CSU); *4 1/2 mi. SW Fort Collins,* 4 (1 CSC, 3 CSU); *4 1/2 mi. SE Fort Collins,* 1 (CSU); *5 mi. SW Fort Collins,* 13 (CSU); *5 mi. SE Fort Collins,* 1 (CSU); *Spring Canyon Dam,* 1 (CSU); *4 mi. S, 3 mi. W Fort Collins,* 2 (CSU); *4 mi. S Fort Collins,* 3 (CSU); *6 mi. SW Fort Collins,* 1 (CU); *4 4/10 mi. S, 3 8/10 mi. W Fort Collins,* 1 (CSU); *Spring Canyon,* 1 (CSU); *5 mi. S, 2 mi. W Fort Collins,* 2 (CSU); *5 mi. S, 1/2 mi. W Fort Collins,* 1 (CSU); *5 mi. S, 1 1/2 mi. E Fort Collins,* 1 (CU); *7 mi. SE Fort Collins,* 3 (CSU); *1/2 mi. S Horsetooth Reservoir,* 1 (CSU); *8 mi. SW Fort Collins, 5765 ft.,* 2 (CSU); *5 3/4 mi. S, 2 1/4 mi. W Fort Collins,* 2 (CSU); *8 3/10 mi. SE Fort Collins, 5200 ft.,* 1 (CSU); *6 mi. S, 1 mi. W Fort Collins,* 1 (CSU); *6 mi. S, 3 mi. E Fort Collins,* 2 (CU); *7 mi. W Windsor,* 1 (CSU); *SW 1/4 sec. 15, T. 6 N, R. 69 W,* 1 (CSU); *7 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *7 mi. NE Loveland,* 2 (CU); *9 mi. S Fort Collins,* 1 (CSU); *1 1/2 mi. N, 12 mi. W Loveland, 5600 ft.,* 2 (KU); *1/2 mi. N, 9 1/2 mi. W Loveland, 5600 ft.,* 3 (KU); *1/2 mi. N, 9 1/4 mi. W Loveland, 5600 ft.,* 4 (KU); *3 1/2 mi. W Loveland, 5030 ft.,* 42 (KU); *Loveland,* 1 (USNM); *1/2 mi. S, 6 mi. W Loveland, 5200 ft.,* 41 (KU); 2 1/2 mi. S, 16 mi. W Loveland, 7280 ft., 1 (KU); *1 mi. N Carter Lake,* 4 (CU). WELD COUNTY: Geary Reservoir, 16 mi. W Grover, 4 (DMNH); 7 mi. N, 1 7/10 mi. E Nunn, 1 (CSU); *NE 1/4 sec. 34, T. 10 N, R. 66 W, 5000 ft.,* 1 (CSU); 14 8/10 mi. NE Fort Collins, 1 (CSU); 3 mi. W Briggsdale, 1 (CSU); *2 1/2 mi. N, 12 1/2 mi. E Fort Collins,* 3 (CSU); 13 mi. E Fort Collins, 1 (CSU); *T. 7 N, R. 66 W,* 1 (CSU); *3 mi. S, 9 mi. E Fort Collins,* 1 (CSU); 5 mi. S, 5 mi. W Greeley, 3 (CSU). LOGAN COUNTY: 4 mi. W Proctor, 1 (WSC). MORGAN COUNTY: Muir Springs, 2 mi. N, 2 1/2 mi. W Fort Morgan, 14 (KU). SEDGWICK COUNTY: 5 mi. SW Julesburg, 1 (DMNH). ADAMS COUNTY: Barr, 6 (DMNH); 3 mi. S, 1 mi. W Simpson, 1 (KU); Bennett, 10 (DMNH). DENVER COUNTY: Denver, 1 (FWS). WASHINGTON COUNTY: 16 mi. S Sterling, 1 (CSU). YUMA COUNTY: 1 1/2 mi. N, 3 1/2 mi. W Wray, 1 (KU); *Wray,* 11 (10 DMNH, 1 WC); *1 mi. W Laird,* 4 (KU); 1 mi. E Laird, 1 (KU); Dry Willow, 7 (DMNH). KIT CARSON COUNTY: Tuttle, 4 (USNM); 3 mi. NE Burlington, 1 (KU); 4 mi. E Flagler, 2 (KU). FREMONT COUNTY: Cañon City, 1 (USNM—see remarks).

Additional records: LARIMER COUNTY: *4 mi. SW Fort Collins* (Reed, 1957:135). WELD COUNTY: 1 mi. S, 6 mi. W Platteville (Archibold, 1964: 44).

Lagurus curtatus

SAGEBRUSH VOLE

Lagurus curtatus occurs in more xeric situations than other Coloradan microtines. It is generally limited to stands of *Artemisia,* or sagebrush mixed with other shrubs, and ranges in elevation from about 5200 feet in Larimer County to 9000 feet in Rio Blanco County. F. W. Miller (1930a) captured sagebrush voles on a sandy flat sparsely covered with sagebrush and greasewood, near Two Bar Spring, Moffat County. The voles occupied abandoned burrows of *Thomomys talpoides.* Clippings of greasewood marked entrances used by the voles. Cary (1911:125) took specimens in a grassy swale near Elk Springs, Moffat County. Like other microtines, *L. curtatus* is at least partially diurnal.

Lagurus curtatus levidensis (Goldman)

Lemmiscus curtatus levidensis Goldman, Proc. Biol. Soc. Washington, 54:70, 31 July 1941; type locality, sandhills 5 mi. E Canadian River, at west base of Medicine Bow Mountains, E of Walden, about 8000 ft., Jackson Co., Colorado.

Lagurus curtatus levidensis, Kelson, Jour. Mamm., 32:114, 15 February 1951.

Distribution in Colorado.—In suitable habitat in northwestern and north-central parts of state (Fig. 85).

Measurements.—Average (and extreme) external measurements of four males, followed by those of six females, from Moffat County, are: 122.3 (117-129), 123.5 (117-130); 20.5

(18-24), 22.7 (19-27); 15.8 (14-17), 16.0 (14-18); 10.5 (10-11), 10.2 (9-11). Selected cranial measurements are presented in table 22.

Remarks.—The range of *L. curtatus* in Colorado is discontinuous, as is its preferred habitat. Populations in northwestern Colorado, in North and Middle parks, and in Larimer County, communicate directly not with each other, but with populations in the Laramie and Wyoming basins. However, the range of the subspecies *levidensis* appears to be generally continuous across Wyoming, and specimens from Moffat County are indistinguishable from specimens from Larimer County.

Records of occurrence.—Specimens examined, 119, distributed as follows: MOFFAT COUNTY: Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 6000 ft., 7 (DMNH); 2 mi. SE Greystone, 1 (CM); *Cross Mountain,* 2 (CM); *2 mi. E Cross Mountain,* 9 (CM); *1 mi. SE Cross Mountain,* 20 (CM); 5 mi. SE Cross Mountain, 1 (CM); *Elk Springs* [labelled "Lily, Elk Springs," but see Cary, 1911:125], 6 (USNM); 1 mi. E Elk Springs, 48 (CM). ROUTT COUNTY: Egeria Park, near Toponas, 9 (USNM). JACKSON COUNTY: *Canadian Creek,* 3 (USNM); 5 mi. E Canadian Creek, 8000 ft., 1 (USNM). LARIMER COUNTY: 4 mi. S, 14 mi. W Livermore, 7500 ft., 1 (KU); 2 mi. N Laporte, 1 (CSU); Fort Collins, 1 (USNM). RIO BLANCO COUNTY: 6 mi. NE Meeker, 1 (CM); *Compass Creek, 9000 ft.* (not found), 7 (AMNH). GRAND COUNTY: 9 1/2 mi. N Kremmling, 1 (CU).

Additional records: MOFFAT COUNTY: *Douglas Spring* (Cary, 1911:125). JACKSON COUNTY: Walden (Warren, 1912a:4). GRAND COUNTY: Hot Sulphur Springs (Warren, 1908b:76).

Ondatra zibethicus

MUSKRAT

The muskrat occurs state-wide in Colorado, to elevations of more than 11,000 feet, wherever suitable still-water habitat is available. On the plains and in major mountain parks, some natural marshes and ponds provide habitat. The recent increase in impounded water on the plains, and the consequent increase in shallow-water and shoreline communities has expanded usable habitat considerably. In the mountains, suitable habitat is less abundant and populations are smaller and more localized. Frequently, *Ondatra zibethicus* occurs as a commensal in beaver-ponds on mountain streams.

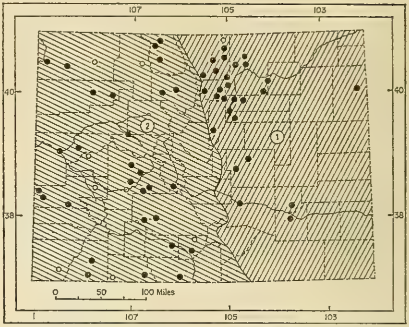


FIG. 86. Distribution of *Ondatra zibethicus* in Colorado. 1. *O. z. cinnamominus.* 2. *O. z. osoyoosensis.* For explanation of symbols, see p. 9.

High populations of muskrats are usual in parts of the San Luis Valley, North Park, the South Platte drainage (especially near the Front Range), the Yampa River Valley, and the lower Arkansas Valley. Complaints against muskrats frequently are registered in irrigated areas, because the burrowing of the animals in ditch-banks may cause considerable damage.

In Colorado, the muskrat is a fur-bearer of some economic importance. However, according to unpublished data furnished by the Division of Game, Fish and Parks, since 1958 the number of muskrat pelts sold annually has not exceeded 30,000. That figure is but a fraction of the harvest during the Second World War (see Remington, 1955).

The races of *O. zibethicus* were revised by Hollister (1911).

Ondatra zibethicus cinnamominus (Hollister)

Fiber zibethicus cinnamominus Hollister, Proc. Biol. Soc. Washington, 23:125, 2 September 1910; type locality, WaKeeney, Trego Co., Kansas.

Ondatra zibethica cinnamomina, G. S. Miller, Jr., Proc. U.S. Nat. Mus., 79:232, 31 December 1912.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 86).

Comparison.—From topotypes of *O. z. osoyoosensis,* topotypes of *O. z. cinnamominus* differ in smaller external and cranial size and in markedly paler color.

Measurements.—External measurements of two males and two females from the vicinity of Fort Collins are: 647, 546, 475, 478; 244, 257, 245, 223; 80, 75, 80, 77; 19, 23, 19, 25;

weights, —, 1150, 1000, 934. Selected cranial measurements of two males and the mean (and extremes) of five females from the vicinity of Fort Collins, are: condylobasal length, 66.4, 63.7, 63.59 (61.4-65.6); zygomatic breadth, 39.7, 39.5, 38.64 (37.8-39.8) interorbital constriction, 6.0, 6.2, 6.02 (5.8-6.5); prelambdoidal breadth, 17.2, 17.2, 17.52 (17.0-18.3); lambdoidal breadth, 27.1, 26.7, 26.24 (25.7-26.8); length of maxillary toothrow, 14.8, 15.1, 15.00 (14.6-16.0).

Remarks.—On the basis of available material, distinction between *O. z. cinnamominus* and *O. z. osoyoosensis* in Colorado is tenuous; reliance here has been on color, because I have found no cranial characters by which to distinguish the two kinds. On the average, specimens from the mountains, herein referred to *osoyoosensis,* are more richly colored than individuals from the plains in comparable pelage. However, the only samples from the plains that are sufficiently large to be of any use are those from Larimer and Boulder counties. Those animals are darker in color than individuals from western Kansas and apparently represent intergrades between *cinnamominus* and *osoyoosensis.*

Records of occurrence.—Specimens examined, 165, distributed as follows: LARIMER COUNTY: 9 mi. N Fort Collins, 3 (CSU); *8 mi. N Fort Collins,* 1 (CSU); *9 mi. NW Fort Collins,* 1 (CSU); *9 mi. NE Fort Collins,* 1 (CSU); *1/2 mi. N Cobb Lake,* 1 (CSU); *7 mi. NW Fort Collins,* 1 (CSU); *4 mi. N, 5 mi. E Fort Collins,* 1 (CSU); *1 mi. W Bellvue,* 1 (CSU); *Watson Lake,* 1 (CSU); *4 mi. NW Fort Collins,* 2 (CSU); *4 mi. NE Fort Collins,* 1 (CSU); *1 mi. W Laporte,* 2 (CSU); *3 mi. NE Fort Collins,* 1 (CSU); *2 mi. NW Fort Collins,* 1 (CSU); *1 mi. N Fort Collins,* 1 (CSU); *1/2 mi. N Fort Collins,* 1 (CSU); *6 mi. W Fort Collins,* 1 (CSU); *2 mi. W Fort Collins,* 1 (CSU); *1 mi. W Fort Collins,* 2 (CSU); *W of Fort Collins,* 1 (CSU); *Fort Collins,* 12 (CSU); *2 1/2 mi. E Fort Collins,* 1 (CSU); *3 mi. E Fort Collins,* 1 (CSU); *3 1/2 mi. E Fort Collins,* 2 (CSU); *5 mi. E Fort Collins,* 3 (1 CSC, 2 CSU); *SE of Fort Collins,* 1 (CSU); *1/4 mi. S Fort Collins,* 2 (CSU); *1 mi. S, 1 mi. W Fort Collins,* 1 (CSU); *1 mi. S Fort Collins,* 2 (CSU); *1 3/10 mi. S Fort Collins,* 1 (CSU); *2 3/10 mi. SE Fort Collins,* 1 (CSU); *2 mi. S, 4 mi. E Fort Collins,* 2 (CSU); *Timnath Reservoir,* 1 (CSU); *3 mi. SE Fort Collins,* 1 (CSU); *1 1/4 mi. NE Timnath,* 1 (CSU); 3 mi. S, 12 mi. W Fort Collins, 1 (CSU); *3 mi. S, 2 mi. E Fort Collins,* 1 (CSU); *4 mi. SE Fort Collins,* 2 (CSU); *1 mi. NE Timnath,* 1 (CSU); *5 mi. SE Fort Collins,* 1 (CSU); *5 9/10 mi. SE Fort Collins,* 1 (CSU); *1 mi. W Timnath,* 3 (CSU); *3 1/2 mi. S, 3 1/2 mi. E Fort Collins,* 3 (CSU); *7 1/2 mi. SE Fort Collins,* 1 (CSC); *1 mi. E Warren Reservoir,* 1 (CSU); *5 mi. S, 1 1/2 mi. E Fort Collins,* 1 (CSU); *5 mi. S, 4 mi. E Fort Collins,* 2 (CSU); *6 mi. S Fort Collins,* 1 (CSU); *6 mi. S, 1 mi. E Fort Collins,* 1 (CSU); *4 mi. W Loveland,* 1 (CU); *3 mi. S Loveland,* 1 (CSU); Longs Peak Inn, 1 (CSU); *no locality other than county,* 1 (CSU). WELD COUNTY: 1 mi. E Ault, 1 (CSU); 3 mi. S, 1 mi. E Windsor, 2 (CSU); 3 mi. N Greeley, 1 (CSC); *2 1/2 mi. N, 1 mi. W Greeley,* 1 (CSU); *14 mi. SE Fort Collins,* 2 (CSU); *2 mi. N, 2 mi. W Greeley,* 1 (CSC); *5 mi. W Greeley,* 1 (CSC); *2 mi. W Greeley,* 1 (CSC); *3 mi. E Greeley,* 1 (CSC); *20th Street Road at 49th Street, Greeley,* 1 (CSC); *T. 3 N, R. 67 W, SE of Berthoud,* 1 (CSU); Empire Reservoir, 1 (DMNH); 30 mi. S Fort Collins, 2 (CSU); *SE Weld County,* 1 (CSC). BOULDER COUNTY: 1 mi. S, 3 mi. E Longmont, 1 (CSU); Ward, 1 (USNM); Boulder, 20 (4 FMNH, 16 CU); *near Boulder,* 1 (CU); *Valmont,* 2 (CU); Coal Creek, 1/2 mi. S, 1 mi. E Lafayette, 2 (CSU); 1 mi. N, 3 mi. W Broomfield, 1 (CSU); *no locality other than county,* 1 (USNM). JEFFERSON COUNTY: *Mount Olivet,* 1 (DMNH); *Federal Center,* 1 (FWS); Foxton, 1 (CSU). ADAMS COUNTY: *sec. 2, T. 1 S, R. 68 W,* 1 (CSU); *1 mi. N, 3 mi. W Broomfield,* 1 (CSU); *N of Barr Lake,* 1 (CU); Barr, 4 (DMNH); *Barr Lake,* 5 (DMNH); Henderson, 1 (DMNH); *Mile Hi Duck Club,* 2 (DMNH); *Brighton Road,* 1 (CU); *Clear Creek at Washington Street,* 1 (DMNH); *Sand Creek,* 2 (DMNH). DENVER COUNTY: Denver, 2 (1 CU, 1 FWS); *Berkeley, Clear Creek,* 1 (CU). ARAPAHOE COUNTY: *Aurora,* 2 (DMNH); Cherry Creek, 1 (DMNH); *no locality other than county,* 1 (DMNH). YUMA COUNTY: Wray, 2 (USNM). EL PASO COUNTY: *2 mi. S Peyton,* 1 (UMMZ); 3 mi. NE Falcon, 1 (UMMZ); *2 mi. S Colorado Springs,* 1 (SCSC); 5 mi. SE Colorado Springs, 1 (CSU). PUEBLO COUNTY: Arkansas River, 10 mi. W Pueblo, 1 (SCSC). CROWLEY COUNTY: Ordway, 1 (FWS). OTERO COUNTY: 3 mi. S, 2 mi. E Rocky Ford, 1 (CSU).

Additional records: LARIMER COUNTY: about 25 mi. N Fort Collins (Warren, 1942:236). EL PASO COUNTY: *Monument Valley Park, Colorado Springs* (Warren, 1924:202).

Ondatra zibethicus osoyoosensis (Lord)

Fiber osoyoosensis Lord, Proc. Zool. Soc. London, p. 97, October 1863; type locality, Lake Osoyoos, British Columbia.

Ondatra zibethica osoyoosensis, G. S. Miller, Jr., Proc. U.S. Nat. Mus., 79:231, 31 December 1912.

Distribution in Colorado.—Highlands of central part of state and at lower elevations on Western Slope (Fig. 86).

Comparison.—For comparison with *O. z. cinnamominus,* see account of that subspecies.

Measurements.—External and cranial

measurements of three males and the mean (and extremes) of four females, all from near Crested Butte, Gunnison County, are: 499, 468, 535, 550.0 (523-581); 219, 177, 225, 240.0 (220-265); 73, 77, 75, 75.5 (73-77); condylobasal length, 61.0, 60.0, 63.4, 63.60, (60.4-66.0); zygomatic breadth, 38.7, 38.7, 38.2, 40.00 (37.8-41.2); interorbital constriction, 5.9, 6.0, 5.3, 5.92 (5.3-6.2); prelambdoidal breadth, 16.5, 17.3, 16.2, 17.75 (16.8-19.2); lambdoidal breadth, 28.4, 26.5, 26.0, 27.30 (26.6-28.5); length of maxillary toothrow, 16.0, 15.2, 15.6, 15.98 (15.5-16.3).

Records of occurrence.—Specimens examined, 69, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 2 (CU); *Yampa River, mouth of canyon to Mantle's Cave,* 1 (CU); Lily, 1 (AMNH). ROUTT COUNTY: *no locality other than county,* 2 (DMNH). JACKSON COUNTY: Independence Mountain, 2 (DMNH); Boettcher Ranch, near Lake John, 2 (DMNH); Hebron, 2 (USNM). RIO BLANCO COUNTY: Meeker, 2 (DMNH); Dry Fork, White River, 6400 ft., 7 (AMNH). EAGLE COUNTY: 5 mi. E Carbondale, 2 (CSU). GRAND COUNTY: *Middle Park,* 1 (CU); Hot Sulphur Springs, 3 (USNM); Grand River, 1 (AMNH). MESA COUNTY: 8 mi. E Palisade, 1 (CSU); Grand Junction, 1 (CU). GUNNISON COUNTY: Crested Butte, 8 (1 MCZ, 7 WC); 3 mi. N Almont, 8300 ft., 1 (KU); Ohio Creek, 2 (WSC); 1/2 mi. E Parlin, 1 (WSC); Cochetopa Creek, 1 (WSC). CHAFFEE COUNTY: 9 mi. W Salida, 1 (KU). MONTROSE COUNTY: West Paradox Valley, 5 (DMNH); Bedrock, 1 (DMNH); Maverick Canyon, 2 mi. N Coventry, 6400 ft., 2 (USNM). SAGUACHE COUNTY: Tevebaugh's Ranch, 20 mi. W Saguache, 5 (USNM); Saguache Park, 1 (USNM). RIO GRANDE COUNTY: Monte Vista, 1 (ASC). ALAMOSA COUNTY: 2 mi. E Alamosa, 1 (ASC). LA PLATA COUNTY: 3 mi. N Durango, 1 (WSC); Fort Lewis, 7600 ft., 1 (KU); 2 mi. NE Bondad, 6100 ft., 1 (KU); Bondad, 1 (DMNH). ARCHULETA COUNTY: Beaver Creek, 1 (DMNH); Navajo River, 7 (DMNH); *no locality other than county,* 1 (DMNH). CONEJOS COUNTY: Antonito, 2 (DMNH).

Additional records (Warren, 1942:236, unless otherwise noted): MOFFAT COUNTY: Lay. ROUTT COUNTY: Steamboat Springs. RIO BLANCO COUNTY: *pond about 1/2 mi. below Buford P. O.* (Felger, 1910:144). PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:37). DELTA COUNTY: 2 1/2 mi. S, 8 mi. E Skyway, 8500-9600 ft. (Anderson, 1959:12). GUNNISON COUNTY: *along East River* (Findley and Negus, 1953:238); *Tomichi Creek, between Gunnison and Parlin* (Cary, 1911:124); 1/2 mi. S Iola Bridge on Gunnison River (Durrant and Robinson, 1962:253). MONTROSE COUNTY: U.S. Highway 50, 18 mi. E Montrose. ALAMOSA COUNTY: San Luis Lakes (Cary, 1911: 124); *Medano Ranch.* MONTEZUMA COUNTY: Mesa Verde National Park (Anderson, 1961:54). ARCHULETA COUNTY: Sambrito Creek, 1/2 mi. N New Mexico boundary (Durrant and Dean, 1961:175).

FAMILY ZAPODIDAE—JUMPING MICE

KEY TO SPECIES OF ZAPODIDAE IN COLORADO

1. Ochraceous lateral line indistinct or lacking; skull light, narrow, zygomatic breadth usually less than 11.5, incisive foramina usually 4.5 or shorter .... *Zapus hudsonius*

   Ochraceous lateral line prominent; skull relatively robust, broad, zygomatic breadth usually 12.0 or greater, incisive foramina usually 4.6 or longer .... *Zapus princeps*

Zapus hudsonius

MEADOW JUMPING MOUSE

Zapus hudsonius is poorly known in Colorado, and apparently is nowhere abundant. Records in the state are marginal for the species and apparently the population there is relict. Given the known preference of the meadow jumping mouse for moist lowland habitats, one would imagine irrigation to have influenced the area of occurrence. A thorough survey of the species in the South Platte Valley in relation to irrigation would be of interest.

Zapus hudsonius and *Z. princeps* are not known to be sympatric in Colorado, although sympatry must be approached in some canyons in the foothills, such as those of Boulder Creek or the Cache la Poudre River. The nearest documented approach of the ranges of the two species is about eight miles, between Gold Hill and Boulder. The two species have a similar geographical relationship in northern Albany County, Wyoming (see Long, 1965: 665, 667).

Zapus hudsonius preblei Krutzsch

Zapus hudsonius preblei Krutzsch, Univ. Kansas Publ., Mus. Nat. Hist., 7:452, 21 April 1954; type locality, Loveland, Larimer Co., Colorado.

Distribution in Colorado.—Known only from western edge of Colorado Piedmont, in South Platte drainage southward to vicinity of Denver (Fig. 87).

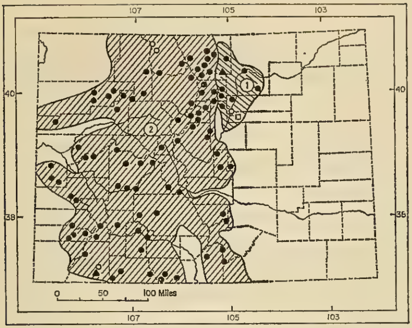


FIG. 87. Distribution of two species of jumping mice in Colorado. 1. *Zapus hudsonius preblei*. 2. *Zapus princeps princeps*. For explanation of symbols, see p. 9.

Comparison.—From *Z. h. campestris*, the subspecies of northeastern Wyoming and adjacent areas, *Z. h. preblei* differs in having a paler, duller dorsum that is less heavily washed with black, and a generally smaller skull with narrower incisive foramina. For more detailed comparisons, see Krutzsch (1954:452).

Measurements.—External measurements of three males and the mean (and extremes) of nine females from Boulder are: 202, 212, 219, 209.8 (198-218); 123, 127, 127, 127.0 (123-133); 31, 29, 30, 29.9 (29-31). Cranial measurements of the above sample include: condylobasal length, 20.1, 20.1, 21.6, 20.18 (19.2-21.5); zygomatic breadth, 11.0, 11.0, 11.2, 11.12 (10.6-11.4) interorbital constriction, 4.0, 3.7, 3.9, 4.06 (3.9-4.3); length of maxillary toothrow, 3.9, 3.9, 4.0, 3.84 (3.7-4.1).

Remarks.—Krutzsch (1954:453) considered *Z. h. preblei* to be a well-marked, isolated geographic race. Its range is separated from that of *Z. h. campestris*, the morphologically most similar named population, by the semiarid area of eastern Wyoming between the North Platte River and the Black Hills. *Zapus h. pallidus* is known from eastern Kansas and westward to Cherry County, Nebraska. Meadow jumping mice are unreported from the South Platte Valley east of Greeley.

Records of occurrence.—Specimens examined, 37, distributed as follows: LARIMER COUNTY: 2 1/2 mi. SE Fort Collins, 1 (CSU); Loveland, 2 (USNM). WELD COUNTY: Greeley, 1 (WC); 6 mi. E Hudson, 5000 ft., 1 (CSU). BOULDER COUNTY: *3 mi. NW Niwot,* 1 (DMNH); 8 1/2 mi. N, 3 1/4 mi. E Boulder, 1 (CU); *Niwot,* 1 (DMNH); Boulder, 24 (4 ANSP, 17 FMNH, 3 USNM); *3 mi. E Boulder,* 1 (CU); *5 mi. E Boulder,* 1 (CU); *S of Boulder,* 1 (CU). JEFFERSON COUNTY: Semper, 1 (KU). ADAMS COUNTY: Croak's [Croke] Lake, 1 (DMNH).

Additional records: DENVER COUNTY: Denver (Cary, 1911:148). ARAPAHOE COUNTY: no precise locality (Warren, 1942:241).

Zapus princeps

WESTERN JUMPING MOUSE

Zapus princeps occurs throughout the moist mountainous regions of Colorado, and may be abundant locally. Extremes of altitudinal range of specimens examined are about 6000 feet at Meeker, and Virginia Basin, above Gothic, 11,500 ft., Gunnison County. A note on the label of the specimen from the latter locality indicates that it was captured under cover of dwarf willows. An association with willows is often characteristic of *Z. princeps* in Colorado. Population maxima seem to occur frequently in streamside *Salix* communities with a lush understory of grasses and herbs. In June 1968, a number of specimens were taken along the North Fork of the Michigan River near Gould, Jackson County, on a barren mud flat beneath a dense growth of willows. Another common habitat is the lush grass and forb synusiae characteristic of mature stands of quaking aspen *(Populus tremuloides).*

Western jumping mice feed almost exclusively on seeds, primarily those of graminoids. The species is known to hibernate, but details of hibernal activity in Colorado are not known. Autumn-taken specimens generally have heavy deposits of fat, particularly in the inguinal region. L. N. Brown (1967a, 1970) studied reproduction and populations of the western jumping mouse in southern Wyoming. Krutzsch (1953) reported an individual from Gothic to have an extra functional molar in each maxillary toothrow.

Zapus princeps princeps J. A. Allen

Zapus princeps J. A. Allen, Bull. Amer. Mus. Nat. Hist., 5:71, 28 April 1893; type locality, Florida, La Plata Co., Colorado.

Distribution in Colorado.—In suitable habitat throughout the mountains and plateaus of western three-fifths of state (Fig. 87).

Comparisons.—From *Z. p. luteus,* a subspecies ranging to the south in New Mexico, *Z. p. princeps* differs in markedly darker dorsal color, and greater external and cranial size. From *Z. p. chrysogenys,* the subspecies of the La Sal Mountains of Utah, *Z. p. princeps* differs in larger size, relatively shorter tail, and more pronounced mid-dorsal stripe (Lee and Durrant, 1960). From *Z. p. utahensis,* the subspecies of western Wyoming and northeastern Utah, *Z. p. princeps* differs in more ochraceous dorsum and sides, broader ochraceous lateral line, and generally smaller skull.

Measurements.—Mean (and extreme) external and cranial measurements of six males, followed by those of four females, all from southern Huerfano County, are: 237.3 (222-250), 234.2 (228-238); 142.4 (132-152), 138.0 (132-145); 32.0 (30-33), 32.0 (31-33); 15.3 (13-17), 15.5 (14-18); condylobasal length, 23.35 (22.8-23.7), 22.85 (22.1-23.2); zygomatic breadth, 12.43 (12.1-12.7), 12.63, (11.8-13.1); interorbital constriction, 4.44 (4.1-4.7), 4.47 (4.1-4.7); length of maxillary toothrow, 4.26 (4.1-4.4), 4.33 (4.1-4-5). Mean weight of four males, 22.67 (20.5-24.0); weights of three females, 20.1, 23.2, 31.3. Average external and cranial measurements of 10 males from the Grand Mesa, six males from Lake County, and six females from northern Boulder County are, respectively: 230.9 (220-244), 229.0 (225-234), 242.7 (228-257); 136.2 (125-144), 142.0 (136-144), 147.3 (137-167); 30.6 (29-33), 31.7 (30-33), 32.7 (31-34); 14.4 (13-16), 14.2 (11-15), 18.7 (12-19); condylobasal length, 22.44 (21.6-23.9), 21.15 (20.7-21.4), 22.60 (22.0-23.6); zygomatic breadth, 12.34 (11.9-12.8), 12.08 (11.7-12.3), 12.38 (11.9-12.8); interorbital constriction, 4.45 (4.3-4.6), 4.43 (4.4-4.5), 4.37 (4.1-4.5); length of maxillary toothrow, 4.07 (3.8-4.2), 4.18 (4.0-4.4), 4.30 (4.2-4.4).

Remarks.—Krutzsch (1954) studied geographic variation in American jumping mice. Available material of *Z. princeps* from Colorado shows little variation, and clearly is referable to a single subspecies. However, a single specimen (KU 16038) from Florida, La Plata County (the type locality of *princeps*) agrees closely in color with specimens of *Z. p. luteus* from near El Rito, Rio Arriba Co., New Mexico. In most cranial characters, however, the individual is similar to other topotypes of *Z. p. princeps.*

A single specimen labelled "Purgatoire R." (USNM 14925) was identified as *Zapus hudsonius* by E. A. Preble in 1900. It consists of a tailless skin in poor condition with skull inside and was not mentioned by Preble (1899) in his revision of the jumping mice. The specimen was collected by W. L. Carpenter on 12 August 1875. It resembles *Z. hudsonius* in general color and pattern of the dorsum, but has the white margins of the pinnae characteristic of many specimens of *Z. princeps.* I judge this specimen to be an immature individual referable to the latter species. The specimen provides the only record of *Z. princeps* east of the Spanish Peaks in southern Colorado. The specimen must have been taken near the head of the Purgatoire River, west of Trinidad, an area where, on ecological grounds, the species would be expected to occur.

Baird (1858:433) referred to "*Jaculus hudsonius*" a specimen from "R. Mountains, 38° par." That specimen, in fact, represents the later-recognized species *Z. princeps.* A specimen from 5 mi. E of Boulder reported by Cockerell *et al.* (1914) as *princeps* is, as would be expected, *Z. hudsonius* (CU 503).

Zapus princeps presently is unknown from extreme western Montrose County. If the species occurs locally on the lower eastern slopes of the La Sal Mountains, one would expect specimens to prove referable to the subspecies *Z. p. chrysogenys.* Similarly, should western jumping mice be found to occur in extreme western Moffat County, the population probably will be found to be allied with *Z. p. utahensis.*

Records of occurrence.—Specimens examined, 365, distributed as follows: ROUTT COUNTY: 7 mi. W Rabbit Ears Pass, 1 (CM); 2 mi. E Toponas, 10,000 ft., 2 (CSU). JACKSON COUNTY: 2 mi. N, 2 mi. E Gould, 5 (KU); Arapaho Pass, 1 (USNM). LARIMER COUNTY: Elkhorn, 2 (USNM); 5 1/2 mi. S Indian Meadows, 7800 ft., 1 (CSU); Rawah Wilderness Area, 10,000 ft., 1 (CSU); *Rawah Lake no. 3, 10,500 ft.,* 1 (CSU); 1/4 mi. W Pingree Park, 1 (CSU); *South Fork Cache la Poudre River, T. 7 N, R. 73 W,* 1 (UNM); North Fork Ranger Station, 3 (RMNP); *Poudre Lakes, 10,700 ft.,* 1 (RMNP); Willow Park, 5 (UMMZ); 2 1/2 mi. S, 19 1/2 mi. W Loveland, 7280 ft., 3 (KU); *Beaver Meadows,* 1 (RMNP); *Hallowell Park,* 9 (RMNP); 3 mi. S, 3 mi. W Estes Park, 1 (KU); *Moraine Park,* 3 (RMNP); *Rocky Mountain National Park, 10,000 ft.,* 1 (UI); *no locality other than county,* 2 (DMNH). RIO BLANCO COUNTY: 9 1/2 mi. SW Pagoda Peak, 7700 ft., 5 (KU); Meeker, 1 (USNM); Ute Creek, 8000 ft., 2 (AMNH); Lost Creek, 9 mi. NE Buford, 1 (CM); between Flag Creek and Grand Hogback, 9 mi. S Meeker, 3 (CM). GARFIELD COUNTY: 1 mi. NW Trappers Lake, 5 (CM); *Stillwater Reservoir, 10,300 ft.,* 3 (DMNH); Dome Peak, Middle Stillwater Creek, 1 (DMNH); Deep Lake, 1 (KU); *head Douglas Creek, 30 mi. S Rangely,* 1 (CM); West Fork Douglas Creek, 8000 ft., 35 mi. S Rangely, 4 (CM). GRAND COUNTY: *Kawuneeche Residence Area,* 4 (RMNP); Grand Lake, 1 (RMNP); 1 mi. N Berthoud Pass, 1 (KU). SUMMIT COUNTY: 1 mi. SE Frisco, 9100 ft., 3 (UI); *1 1/2 mi. S Frisco, 9500 ft.,* 1 (UI). BOULDER COUNTY: 12 1/2 mi. S Estes Park, 8400 ft., 2 (KU); *3/4 mi. N, 2 mi. W Allenspark,* 9 (KU); 10 mi. NW Nederland, 10,000 ft., 3 (CU); Gold Hill, 2 (USNM); *7 mi. NW Nederland,* 2 (UMMZ); *Science Lodge,* 1 (CU); *1/4 mi. SW Sunset,* 1 (CU); *3 mi. SSW Ward,* 2 (CU); *3 mi. S Ward, 9000 ft.,* 1 (KU); *4 1/2 mi. S, 1 mi. W Nederland,* 1 (FHSC); 3 mi. E Pinecliff, 3 (DMNH); *no locality other than county,* 2 (DMNH). GILPIN COUNTY: Blackhawk, 1 (USNM); *Dory Hill Pond, near Blackhawk,* 1 (ANSP). CLEAR CREEK COUNTY: 10 mi. N Mount Evans, 1 (CU); *Silverplume,* 2 (SC); Camp Lemon, 5 mi. above Silverplume, 9000 ft., 2 (1 DMNH, 1 SC); Mount Evans, 6 (CU). JEFFERSON COUNTY: 9 mi. S, 12 mi. W Waterton, 1 (FHSC). MESA COUNTY: Palisade, 2 (FMNH); 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft., 3 (KU); Uncompahgre Butte, 8500 ft., 1 (USNM); 15 mi. E Gateway, 1 (KU). LAKE COUNTY: 8 mi. SW Leadville, 21 (KU). PARK COUNTY: 8 mi. NNW Grant, 10,000 ft., 4 (FWS); 2 1/2 mi. S Estabrook, 2 (FHSC); Alma, 1 (CSU). DELTA COUNTY: 12 mi. S, 5 mi. E Collbran, 10,000 ft., 3 (KU); 1/2 mi. S, 8 mi. E Skyway, 9500 ft., 3 (KU); *1 mi. S, 8 mi. E Skyway, 10,000 ft.,* 6 (KU); *2 mi. S, 8 mi. E Skyway, 9000 ft.,* 3 (KU); *2 1/2 mi. S, 8 mi. E Skyway, 9600 ft.,* 4 (KU). GUNNISON COUNTY: 1 mi. W McClure Pass, 8650 ft., 2 (KU); *Virginia Basin, 11,500 ft.,* 1 (UMMZ); *Gothic Mountain,* 1 (ANSP); *near Gothic, 10,500 ft.,* 1 (UMMZ); *Rocky Mountain Biological Laboratory,* 2 (USNM); *1/2 mi. S Rocky Mountain Biological Laboratory,* 1 (KU); Gothic, 24 (7 ANSP, 1 KU, 1 UNM, 15 USNM); near Beckwith Pass, 9 (6 KU, 3 UNM); Taylor Park, 1 (DMNH); Black Mesa, 9 mi. NNW Sapinero, 9500 ft., 3 (KU); *Black Mesa,* 1 (CU); 7 1/2 mi. W Gunnison, 1 (FWS); near Tomichi Creek, 1 mi. E Gunnison, 1 (WSC); *no locality other than county,* 19 (ANSP). CHAFFEE COUNTY: E side Monarch Pass, 17 mi. W Salida, 11,000 ft., 1 (CM); 10 mi. SW Salida, 8500 ft., 7 (KU). TELLER COUNTY: 10 mi. N Florissant, 8900 ft., 7 (FWS); *6 mi. NNE Florissant, 8900 ft.,* 6 (FWS); 13 mi. SW Woodland Park, 9500 ft., 3 (CSU). EL PASO COUNTY: Minnehaha, 1 (UMMZ); *Halfway,* 5 (UMMZ). MONTROSE COUNTY: NW 1/4 sec. 21, T. 48 N, R. 13 W, 9000 ft., 1 (KU); 13 mi. N, 7 mi. E Norwood, 1 (KU). OURAY COUNTY: Red Mountain Pass, 5 (SC). SAN MIGUEL COUNTY: Lone Cone, 1 (SC). SAGUACHE COUNTY: Tevebaugh's Ranch, 20 mi. W Saguache, 1 (USNM); Saguache Park, 1 (USNM). CUSTER COUNTY: 1 1/2 mi. N, 1 1/2 mi. W Fairview, 9000 ft., 10 (KU); 1 1/2 mi. SW San Isabel, 8900 ft., 2 (KU). DOLORES COUNTY: 12 mi. N Rico, 1 (SC); sec. 13, T. 40 N, R. 13 W, 8100 ft., 3 (KU); 5 mi. N, 3 mi. E Stoner, 8800 ft., 2 (KU). SAN JUAN COUNTY: 6 1/2 mi. SW Silverton, 9900 ft., 4 (KU). HINSDALE COUNTY: 7 mi. S, 2 mi. W Lake City, 9000 ft., 2 (KU). MINERAL COUNTY: Creede, 1 (KU); *3 mi. E Creede,* 1 (KU); 5 mi. S, 6 mi. E Wagon Wheel Gap, 8500 ft., 2 (KU); 23 mi. S, 11 mi. E Creede, 9300 ft., 5 (KU). HUERFANO COUNTY: La Veta Pass, 1 (AMNH); *4 mi. S Cucharas Camps,* 4 (KU); 5 mi. S, 1 mi. W Cucharas Camps, 10,000 ft., 10 (KU). LA PLATA COUNTY: 8 mi. N, 2 mi. W Hesperus, 1 (UI); Florida, 6800 ft., 11 (9 AMNH, 1 FMNH, 1 KU). ARCHULETA COUNTY: Devil's Creek, near Dyke, 2 (DMNH); headwaters Navajo River, 1 (DMNH); *Upper Navajo River,* 5 (DMNH); *Navajo River,* 7 (DMNH); NW 1/4 sec. 23, T. 32 N, R. 6 W, 1 (UNM). CONEJOS COUNTY: 12 mi. NE Cumbres, 6 (AMNH); Antonito, 1 (USNM); *4 mi. S, 23 mi. W Antonito,* 1 (KU); 5 mi. S, 24 mi. W Antonito, 9600 ft., 15 (KU). COSTILLA COUNTY: [near] Fort Garland, 8 (USNM). County unknown: *Rocky Mountains, about 38°N,* 1 (USNM).

Additional records (Warren, 1912a:4, unless otherwise noted): ROUTT COUNTY: *Gore Pass Road, 5 mi. E Toponas.* JACKSON COUNTY: Mount Zirkel; near Lake John. GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:43). BOULDER COUNTY: *near Science Lodge, about 10,000 ft.* (Williams and Finney, 1964: 265). GILPIN COUNTY: *Moon Gulch* (Williams, 1955b:224). GUNNISON COUNTY (Durrant and Robinson, 1962:254, unless otherwise noted): *Copper Lake, 3 7/10 mi. NE Gothic, 11,100 ft.* (Findley and Negus, 1953:238); *East River, 6/10 mi. NW Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *1 mi. SE Gothic, 9600 ft.* (Findley and Negus, *loc. cit.*); *4 mi. up Soap Creek from Sapinero, 7520 ft.; 1 mi. up Red Creek, 7544 ft.; Steuben Creek, 4/10 mi. from mouth, 7440 ft.; Red Creek, 1/4 mi. above Gunnison River, 7340 ft.; Dry Gulch at Gunnison River, 7400 ft.; West Elk Creek at Gunnison River, 7400 ft.; 2 mi. up Lake Fork.* LA PLATA COUNTY: 7 mi. N Florida, 7146 ft. (Davis, 1934:227). ARCHULETA COUNTY: *Sambrito Creek, 1/2 mi. N New Mexico boundary* (Durrant and Dean, 1961: 176).

Family Erethizontidae—Porcupine

Erethizon dorsatum

Porcupine

The porcupine is the sole boreal representative of an otherwise Neotropical family. Although primarily a mammal of coniferous forests, the porcupine ranges to a considerable extent into the broad-leafed forests in eastern United States. In Colorado, porcupines occur throughout the mountains and may be abundant locally. They are not uncommon on scarp woodlands in the southeastern part of the state, and occasional individuals wander eastward onto the plains, particularly in riparian woodlands. However, records from the eastern plains are few. That the range of the species is potentially statewide in Colorado is indicated by its documented occurrence in western Nebraska (Jones, 1964:242) and western Kansas (Cockrum, 1952:217).

Porcupines feed on various classes of plant material, but probably their most conspicuous food item is the inner bark of trees, particularly conifers. Damage by porcupines is commonly apparent in stands of pine, notably piñon and ponderosa. The damage done may be considerable, affecting the value of timber species and killing smaller trees outright. Furthermore, the animals may damage orchards and other cultural plantings. For details on the effect of porcupines in Mesa Verde National Park, see Wright *et al.* (1933), Cahalane (1948), and Anderson (1961).

Erethizon dorsatum bruneri Swenk

Erethizon epixanthum bruneri Swenk, Univ. Nebraska Studies, 16:117, 21 November 1916; type locality, 3 mi. E Mitchell, Scotts Bluff Co., Nebraska.

Erethizon dorsatum bruneri, Anderson, Bull. Nat. Mus. Canada, 102:173, 24 January 1947.

Distribution in Colorado.—Documented only from Rim of High Plains, northern Weld County; to be expected occasionally along eastern boundary of state (Fig. 88).

Comparison.—From *E. d. epixanthum,* the subspecies adjacent to the west, *E. d. bruneri* differs in slightly larger overall size, relatively shorter hind foot, paler, duller color, more spatulate nasals (broader anteriorly, narrower posteriorly), and larger auditory bullae (Swenk, 1916:117).

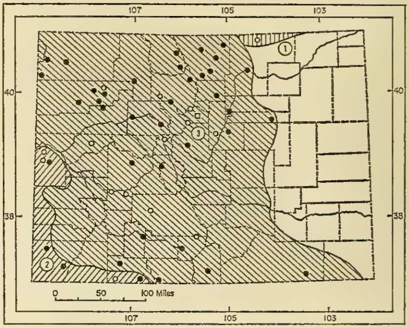


Fig. 88. Distribution of *Erethizon dorsatum* in Colorado. 1. *E. d. bruneri.* 2. *E. d. couesi.* 3. *E. d. epixanthum.* For explanation of symbols, see p. 9.

Measurements.—I have examined no Coloradan specimens of this subspecies. External measurements of two females from Sioux and Banner counties, Nebraska, are: 820, 875; 240, 205; 110, 108; 35, 22. Selected cranial measurements of three females from western Nebraska include: condylobasal length, 116.4, 111.3, 99.3; basilar length, 102.5, 88.4, 83.5; zygomatic breadth, 74.7, 68.5, 69.3; interorbital constriction, 31.7, 29.3, 28.5; length of nasals, 41.8, 40.8, 39.2; greatest breadth of both nasals, 22.4, 22.1, 23.1; length of maxillary toothrow, 28.5, 26.9, 27.8.

Remarks.—The name *E. d. bruneri* has been applied to porcupines from the Great Plains (see Cockrum, 1952:218; Jones, 1964: 242). Long (1965:669) referred to the subspecies animals from the entire eastern half of Wyoming. That author (*loc. cit.*) characterized *bruneri* as being smaller than *epixanthum* and having less inflated auditory bullae, opposite the situation suggested by Swenk (1916—see comparison above) in his original description of *bruneri.*

A single Coloradan record is herein admitted as *bruneri,* that following Warren (1942:244). For further remarks on taxonomy of Coloradan porcupines, see the account of *E. d. epixanthum.*

Records of occurrence.—Specimens examined, none.

Additional record: WELD COUNTY: Geary Reservoir, 9 mi. W Grover (Warren, 1942:244).

Erethizon dorsatum couesi Mearns

Erethizon epixanthus couesi Mearns, Proc. U. S. Nat. Mus., 19:723, 30 July 1897; type locality, Fort Whipple, Yavapai Co., Arizona.

Erethizon dorsatum couesi, Hall, Mammals of Nevada, p. 649, 1 July 1946.

Distribution in Colorado.—Southwestern part of state at lower elevations (Fig. 88).

Comparison.—From *E. d. epixanthum,* the subspecies to the north and east in Colorado, *E. d. couesi* differs in smaller external and cranial size, slightly paler color, and in cranial details, particularly in the presence of slightly more inflated bullae (Durrant, 1952:393).

Measurements.—External and cranial measurements of an old female (KU 69470) from Mesa Verde National Park are: 720, 220, 99; weight, 5700; condylobasal length, 103.0; basilar length, 89.7; zygomatic breadth, 69.4; interorbital constriction, 33.0; length of nasals, 31.4; greatest breadth across both nasals, 21.8.

Remarks.—*Erethizon d. couesi* was first reported from Colorado by F. W. Miller (1924a). For comments on variation in Coloradan porcupines, see the account of *E. d. epixanthum.*

Records of occurrence.—Specimens examined, 7, distributed as follows: MESA COUNTY: *Grandview Overlook, Colorado National Monument,* 1 (CU); 20 mi. SW Grand Junction, 5500 ft., 1 (CSU). MONTEZUMA COUNTY: Yellowjacket, 1 (CU); Mancos River, Mesa Verde National Park, 6200 ft., 2 (KU). LA PLATA COUNTY: Allison, 1 (UNM). ARCHULETA COUNTY: near Chromo, 8500 ft., 1 (DMNH).

Additional records: MESA COUNTY (P. H. Miller, 1964:75): 1/4 mi. W Red Canyon View, 6400 ft.; *1/2 mi. E Independence View, 5827 ft.;* 4 mi. S, 1 mi. E Glade Park Store, 7000 ft. ARCHULETA COUNTY: San Juan River, mile 180 (Durrant and Dean, 1961:177).

Erethizon dorsatum epixanthum Brandt

Erethizon epixanthus Brandt, Mem. Acad. Imp. Sci. St. Petersbourg, ser. 6, Sci. Math. Phys. et Nat., 3:390, 1835; type locality California (see Hollister, 1913:27, or Swenk, 1916:5).

Erethrizon [sic] dorsatus epixanthus, True, Proc. U. S. Nat. Mus., 7 (App., Circ. 29):600, 29 November 1884.

Distribution in Colorado.—Throughout higher parts of state, except southwestern corner, and occasionally onto the eastern plains (Fig. 88).

Comparisons.—For comparison with other nominal subspecies in Colorado, see accounts of those races.

Measurements.—External measurements of a female from Larimer County are: 814, 280, 98, 25. Representative cranial measurements of a male from southern Larimer County, a male and a female from southern Grand County, and a male and a female from northern Gunnison County are, respectively: condylobasal length, 103.0, 110.1, 102.9, 103.9, 99.9; basilar length, 89.7, 97.6, 91.5, 91.7, 87.6; zygomatic breadth, —, 73.4, —, 69.8, 69.5; interorbital constriction, 28.4, 33.6, 32.5, 31.0, 29.9; length of nasals, 37.5, 40.1, 35.5, 38.0, 36.5; greatest breadth of both nasals, 21.1, 24.0, 23.2, 21.6, 20.5; length of maxillary toothrow, 27.6, 25.6, 27.7, 30.6, 24.9.

Remarks.—Porcupines are locally abundant in the mountains of Colorado, but, in proportion to their natural numbers, are poorly represented in museum collections. Among the specimens examined, wide variation in cranial proportions and external features is apparent. However, in no instance have I examined adults in a geographically coherent series of sufficient size to gain any but the most general idea of the amount of individual variation within a population. I have not made direct comparisons between the two largest series of specimens (from Larimer and Rio Blanco counties), but where direct comparison has been possible, animals from throughout the mountainous parts of the state were found to be within the range of variation of a series from a single circumscribed area.

The few animals available from lower elevations in the southwestern part of the state seem to be consistently smaller than those from the mountains to the north and east and are herein referred to *E. d. couesi.* Available material is too meager to allow description of intergradation in southwestern Colorado between *couesi* and *epixanthum,* but such doubtless exists.

Records of occurrence.—Specimens examined, 56, distributed as follows: MOFFAT COUNTY: Pot Creek, near Pat's Hole, 1 (DMNH); 5 mi. NW Cross Mountain, 1 (CM); 11 mi. N, 11 mi. W Rangely, 6000 ft., 1 (KU). ROUTT COUNTY: 7 mi. SW Oak Creek, 7100 ft., 1 (CSU). JACKSON COUNTY: Medicine Bow Range, 2 (DMNH);

Homestead Ranch, 1 (DMNH). LARIMER COUNTY: 18 mi. N Fort Collins, 1 (CSU); 1 1/2 mi. NW Rustic, 1 (CSU); *9 mi. N, 17 mi. W Fort Collins,* 1 (CSU); 4 mi. N, 6 mi. W Fort Collins, 1 (CSU); 1 mi. SW Drake, 1 (KU); *Fall River Entrance, Rocky Mountain National Park,* 1 (RMNP); *Utility Area,* 1 (RMNP); 5 mi. SW Estes Park, 1 (KU); *Bear Lake Road, 1/2 mi. above Mill Creek ranger houses,* 1 (RMNP); *4 mi. S Estes Park,* 1 (KU). WELD COUNTY: Greeley, 1 (KU). RIO BLANCO COUNTY: Dry Fork, White River, 10 (AMNH); Ute Creek, 8000 ft., 1 (AMNH); 15 mi. SE Meeker, 1 (CM); 6 mi. E Little Hills Experiment Station, 6200 ft., 1 (CSU). GARFIELD COUNTY: Mud Springs, 1 (WC). EAGLE COUNTY: junction Colorado and Eagle rivers, 1 (FMNH); 10 mi. W Vail Pass, 1 (KU). GRAND COUNTY: west side Rocky Mountain National Park, 1 (RMNP); near Sheephorn Pass, 2 (WC). BOULDER COUNTY: Boulder, 1 (WC); *Magnolia,* 1 (WC); *no locality other than county,* 1 (USNM). DENVER COUNTY: Denver, 2 (1 DMNH, 1 FWS). ARAPAHOE COUNTY: Deer Trail, 1 (DMNH). PARK COUNTY: South Park, 1 (DMNH). DOUGLAS COUNTY: Sedalia, 1 (CU). GUNNISON COUNTY: Gothic, 1 (ANSP); *7 mi. N Crested Butte, 9500 ft.,* 1 (KU). CHAFFEE COUNTY: Cottonwood Pass, 1 (UMMZ). SAGUACHE COUNTY: *5 mi. N, 22 mi. W Saguache, 10,000 ft.,* 1 (KU); 4 mi. N, 20 mi. W Saguache, 9000 ft., 1 (KU). MINERAL COUNTY: 2 mi. E Wagon Wheel Gap, 8700 ft., 1 (KU). ALAMOSA COUNTY: 5 mi. NW Alamosa, 1 (ASC). ARCHULETA COUNTY: junction Gordon Creek and Piedra River, 1 (UNM). CONEJOS COUNTY: Osier, 1 (DMNH). COSTILLA COUNTY: 1 mi. S San Luis, 7900 ft., 1 (KU). LAS ANIMAS COUNTY: 3 1/2 mi. S, 5 mi. W Kim, 1 (KU).

Additional records: ROUTT COUNTY: *California Park* (Felger, 1910:144). RIO BLANCO COUNTY (Felger, *loc. cit.*): head Williams Fork [of Yampa?]; White River Valley. GRAND COUNTY: Highbridge, Berthoud Pass (Cary, 1911:150); 6 mi. S Kremmling (Lechleitner, 1958:447). SUMMIT COUNTY: Gray's Peak (KU catalog, specimen not found). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:225). JEFFERSON COUNTY: North Fork South Platte River, below Foxton (Kalmbach, 1953:511). MESA COUNTY: 10 mi. W Collbran (P. H. Miller, 1964:75—reported as *couesi,* referred to *epixanthum* on geographic grounds). LAKE COUNTY: 5 mi. N Leadville on Colorado Highway 91 (Dexter, 1957:526). PARK COUNTY: Mount Lincoln (Blake and Blake, 1969: 36). GUNNISON COUNTY (Durrant and Robinson, 1962:254): Gunnison River, 3/4 mi. SW Sapinero, 7340 ft.; 2 mi. above mouth of Cebolla Creek, 7400 ft. ALAMOSA COUNTY: Medano Springs Ranch, near San Luis Lakes (Cary, 1911: 150).

Order CARNIVORA

Twenty-four Recent species of the order Carnivora are known to occur naturally in Colorado. Populations of some have been reduced drastically, and possibly extirpated, within historic times. Coloradan carnivores represent five families.

Two species of the Carnivora (*Ursus americanus* and *Felis concolor*) are considered to be big game mammals in Colorado, and a number of other kinds are subject to licensed trapping as fur-bearers. The following carnivores are fully protected under hunting regulations for 1970: *Ursus arctos, Mustela erminea, Gulo gulo, Lutra canadensis,* and *Lynx canadensis.* The fisher, unknown from Colorado, also is protected. A number of species, formerly considered to be predators and afforded no protection, recently have been recognized by statute as "non-game" mammals, and now are subject to licensed hunting. Among non-game mammals under the law are such poorly known species as the kit and swift foxes and the hog-nosed skunk. Elsewhere, I have commented (Armstrong, 1971a) on current regulations pertaining to non-game mammals.

In many instances, populations of carnivores seem incompatible with the economic interests of man. The usual response has been programs aimed at eradication or "control," rather than ecologically sound management. Due to their secretive habits and generally sparse populations, the natural history of many kinds of carnivores is poorly understood. Without a basic understanding of the biology of a species, scientific management is impossible. Field studies of carnivores must be encouraged strongly. A possible result is an understanding of natural balances before they are irrevocably destroyed.

Key to Families of Carnivora in Colorado

1. Hind foot five-toed 2
   Hind foot four-toed 4

2. Tail shorter than hind foot; three molars, total teeth 42 .... *Ursidae*
   Tail longer than hind foot; two lower molars, total teeth 40 or fewer 3

3. Tail conpicuously ringed, musk glands absent; molars 2/2, total teeth 40 .... *Procyonidae*
   Tail not ringed, musk glands present; molars 1/2, total teeth 38 or fewer .... *Mustelidae*
4. Claws non-retractile; molars 2/3, total teeth 42 .... *Canidae*
   Claws retractile; molars 1/1, total teeth 28 or 30 .... *Felidae*

FAMILY CANIDAE—DOGS AND ALLIES

KEY TO SPECIES OF CANIDAE IN COLORADO

1. Postorbital process thick, convex dorsally; condylobasal length greater than 160 2
   Postorbital process thin, concave dorsally; condylobasal length less than 50 3
2. Condylobasal length usually less than 190; with mandible articulated and jaws closed, tips of upper canines extend below line connecting mental foramina .... *Canis latrans*
   Condylobasal length usually more than 210; with mandible articulated and jaws closed, tips of upper canines do not usually reach a line connecting mental foramina .... *Canis lupus*
3. Posterior aspect of pinnae red; temporal ridges distinctly lyriform; obvious notch at posterior end of horizontal ramus of dentary .... *Urocyon cinereoargenteus*
   Posterior aspect of pinnae not red; temporal ridges forming saggital crest and not distinctly lyriform; posterior end of horizontal ramus of dentary not notched 4
4. Tip of tail white, posterior aspect of pinnae black; condylobasal length greater than 130 .... *Vulpes vulpes*
   Tip of tail dark, posterior aspect of pinnae grayish brown; condylobasal length less than 120 5
5. Ears long, greater than 75 from notch; auditory bullae relatively large .... *Vulpes macrotis*
   Ears short, less than 75 from notch; auditory bullae relatively small .... *Vulpes velox*

Canis latrans

COYOTE

The coyote is widespread in North America, occurring from the Pacific Coast eastward to the Great Lakes Region, and from Costa Rica to the Arctic Slope of northern Alaska. The species is statewide in Colorado.

According to S. P. Young (1951:11), the coyote "... originally was strictly an animal of the plains, but . . . in comparatively recent years it has followed livestock and game into forested areas of the mountains." Probably the language of the foregoing observation is too categorical. While it doubtless is true that the relative abundance of coyotes on the plains and in the mountains has changed dramatically since settlement, I doubt that mountainous areas of Colorado were previously devoid of the species. It is true that large tracts of unbroken montane or subalpine forest support relatively low populations of species suitable as prey for coyotes. Probably such areas were avoided in the past as they are today. On the other hand, the montane environment is a mosaic of forests, parklands and canyons. The abundant "edge" created by the presence of parks and canyons supports large populations of prey species, and more than likely *Canis latrans* has long been among the predators in such communities.

Coues (1879:218) noted the abundance of coyotes in Colorado, reporting this canid as ". . . occurring in the mountains as well as on the plains." J. A. Allen (1874:54), commenting on the coyote in South Park in 1871, wrote: "Formerly exceedingly numerous, but now greatly reduced in numbers."

Because of their real and imagined depredations against domestic livestock and game birds and mammals, coyotes have been the objective of intensive control campaigns. Numbers of coyotes have been reduced in some parts of the state, but other areas support large populations today. Cahalane (1948) documented changes in numbers in National Parks and Monuments in Colorado. Much of the vast literature on predator control contains information on the coyote in Colorado. The study by Young (1951) summarized literature to that time. Robinson (1961) discussed effects of control programs on non-target species. Presnall and Wood (1953) noted predation by coyotes on upland game birds.

According to unpublished data furnished by the Division of Game, Fish and Parks, employees of the Branch of Predator and Rodent Control of the U. S. Fish and Wildlife Service killed 7703 coyotes in Colorado during 1962. That figure is based on actual counts and is doubtless unrealistic, inasmuch as only 337 animals (4.3 per cent of the total) were reported as poisoned (recovery of poisoned predators is low). In an era of ecological management of natural resources, programs aimed at eradication of predators are anachronistic at best. Considering the important role of coyotes in maintaining healthy populations of herbivores, management of coyotes as a renewable resource is a more realistic approach.

Few persons who are familiar with the coyote in the wild would be in favor of the extirpation of the species. Coues and Yarrow (1875:45) aptly expressed the fascination of the coyote: "Practically, the Coyoté is a nuisance; theoretically, he compels a certain degree of admiration, viewing his irrepressible positivity of character and his versatile nature. . . . The main object of his life seems to be the satisfying of a hunger . . . and to this aim all his cunning, intelligence, and audacity are mainly directed."

The subspecies of *C. latrans* were revised by Jackson (1951); that revision generally is followed herein.

Canis latrans latrans Say

Canis latrans Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:168, 1823; type locality, Engineer Cantonment [approximately 2 mi. E Fort Calhoun, Washington Co.], Nebraska.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 89).

Comparisons.—From *C. l. lestes,* the subspecies geographically adjacent to the west, *C. l. latrans* differs in slightly smaller average size, both externally and cranially, and paler color, generally with the markings buff or pale brown rather than dark brown to black.

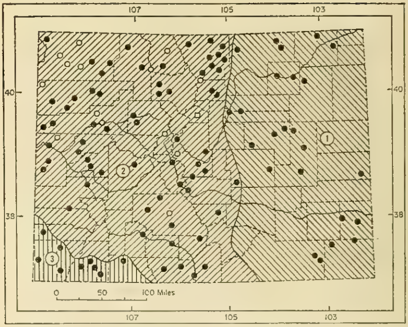


FIG. 89. Distribution of *Canis latrans* in Colorado. 1. *C. l. latrans.* 2. *C. l. lestes.* 3. *C. l. mearnsi.* For explanation of symbols, see p. 9.

From *C. l. mearnsi,* the subspecies of the desert Southwest, *C. l. latrans* differs in larger overall size and paler color.

Measurements.—External measurements of males from Weld County and Elbert County, and a female from Cheyenne County, are, respectively: 1210, 1143, 1107; 521, 342, 330; 91, 76, 70; 98, 121, 70; weights (pounds), 14, 25, 23. Selected cranial measurements of five males from Weld, Morgan, Logan, Elbert, and Lincoln counties, respectively, are: 177.0, 172.5, 183.2, 175.0, 187.0; zygomatic breadth, 92.8, 87.2, 91.2, 98.6, 93.5; interorbital constriction, 30.5, 26.5, 28.9, 31.8, 32.1; mastoid breadth, 57.8, 57.2, 62.8, 60.4, 57.8; length of nasals, 69.6, 62.5, 74.4, 72.6, —; length of maxillary toothrow, 82.0, 79.3, 84.4, 79.2, 85.8. Cranial measurements of four females from El Paso, Lincoln, and Cheyenne counties, include: condylobasal length, 178.1, 178.5, 166.0, 175.0; zygomatic breadth, 94.8, 90.1, 85.4, 93.3; interorbital constriction, 31.5, 30.7, 28.7, 29.1; mastoid breadth, 61.3, 58.8, 57.4, 59.2; length of nasals, 72.9, 74.8, 65.4, 69.9; length of maxillary toothrow, 83.3, 81.7, 79.9, 78.9.

Remarks.—The pattern of geographic races described by Jackson (1951) and utilized herein, describes only in a general way the geographic variation to be seen in Coloradan coyotes. Considering only Coloradan animals, one might treat them as a continuously grading series; boundaries between adjacent races are indistinct. When specimens from surrounding areas are considered, however, it is apparent that at least three subspecies can be recognized. Along the eastern flank of the mountains, coyotes generally are pale in color, like those of the adjacent plains, but in their large size tend to approach the phenotype more typical of montane populations. In the southeastern part of the state, available material also indicates a trend toward large size, individuals approaching *C. l. lestes* of the mountains or perhaps *C. l. texensis* of the southern Great Plains.

Records of occurrence.—Specimens examined, 32, distributed as follows: WELD COUNTY: 10 mi. E Grover, 1 (CSU); Pawnee Buttes, 1 (USNM); 1 mi. S Nunn, 1 (CSU); *no locality other than county,* 1 (DMNH). MORGAN COUNTY: 1 mi. N, 3 mi. W Fort Morgan, 1 (CU); Brush, 1 (USNM). LOGAN COUNTY: SW 1/4 sec. 23, T. 12 N, R. 22 [52] W, 1 (KU); 10 mi. NE Fleming, 1 (CU). ADAMS COUNTY: *Box Elder,* 1 (AMNH). DENVER COUNTY: Denver City, 1 (USNM). ARAPAHOE COUNTY: 18 mi. E Denver, 1 (FWS). WASHINGTON COUNTY: East Pinneo, 2 (USNM). ELBERT COUNTY: 6 mi. N Riverbend, 1 (CU); Kuhn's Crossing, 6000 ft., 1 (USNM); 6 mi. S Elbert, 1 (CSU). LINCOLN COUNTY: 12 mi. NW Genoa, 1 (CSU); Hugo, 1 (CU); *1 1/2 mi. N, 2 mi. E Karval,* 1 (CU); 3 mi. E Karval, 1 (CU). EL PASO COUNTY: 2 mi. S, 2 mi. W Yoder, 1 (SCSC). CHEYENNE COUNTY: 8 mi. S, 4 mi. E Cheyenne Wells, 1 (CSU). PROWERS COUNTY: 10 mi. S Granada, 1 (CSU); 15 1/2 mi. N, 1 mi. E Springfield, 1 (KU). LAS ANIMAS COUNTY: 25 mi. NW Estelene, 4 (USNM); 13 mi. NW Estelene, 3 (USNM). BACA COUNTY: Gaume's Ranch, 1 (WC).

Additional records: WELD COUNTY: 9 mi. N, 3 mi. E Nunn (Engel and Vaughan, 1966:143). ELBERT COUNTY: Deming Ranch [T. 7-8 S, R. 62-63 W] (Young, 1951:89). CROWLEY COUNTY: no precise locality (Rapp, 1962:217). LAS ANIMAS COUNTY: Apishapa River, near Thatcher (Young, 1951:142).

Canis latrans lestes Merriam

Canis lestes Merriam, Proc. Biol. Soc. Washington, 11:25, 15 March 1897; type locality, Toyabe Mountains, near Cloverdale, Nye Co., Nevada.

Canis latrans lestes, Grinnell, Proc. California Acad. Sci., ser. 4, 3:285, 28 August 1913.

Distribution in Colorado.—Western three-fifths of state, except extreme southwestern corner (Fig. 89).

Comparisons.—*Canis l. lestes* resembles *C. l. mearnsi* in color, but is slightly more blackish and less reddish; *lestes* is larger than *mearnsi* both externally and cranially.

For comparison with *C. l. latrans,* see account of that subspecies.

Measurements.—Selected cranial measurements of three males from the vicinity of Gypsum, Eagle County, and a female from Rio Blanco County are, respectively: condylobasal length, 172.0, 182.0, 186.0, 188.0; zygomatic breadth, 89.1, 95.0, 101.1, 105.6; interorbital constriction, 28.9, 29.2, 32.9, 36.7; mastoid breadth, 54.9, 58.9, 62.5, 65.3; length of nasals, 70.4, 76.5, 73.3, 79.9; length of maxillary toothrow, 81.1, 83.9, 85.5, 84.5.

For additional measurements, see Jackson (1951:281).

Records of occurrence.—Specimens examined, 267, distributed as follows: MOFFAT COUNTY: Brown's Park, 2 mi. E Ladore, 1 (USNM): Lay, 2 (USNM); Craig, 9 (USNM); Iles Mountain, 1 (USNM). ROUTT COUNTY: *California Creek,* 1 (USNM); California Park, 1 (USNM); Quaker Mountain, 1 (USNM); Steamboat Springs, 3 (USNM). JACKSON COUNTY: Spicer, 1 (USNM). LARIMER COUNTY: 1/2 mi. S Halligan Reservoir, 6600 ft., 1 (CSU); McIntyre Ranch [sec. 8, T. 10 N, R. 75 W], Laramie District, Colorado [Roosevelt] National Forest, 1 (USNM); *Hass Ranch Pass,* 1 (USNM); *Laramie District, Colorado [Roosevelt] National Forest,* 3 (USNM); 18 mi. N Fort Collins, 1 (CU); *Rist Canyon, 20 mi. [by road] NW Fort Collins, 7000 ft.,* 1 (CSU); 1/2 mi. N Cement Plant [E of Laporte], 1 (CU); 2 mi. N, 20 mi. W Fort Collins, 1 (CU); Timnath Reservoir, 1 (CSU); Arkins, 8 (USNM); Loveland, 3 (USNM); Estes Park, 1 (AMNH). RIO BLANCO COUNTY: Meeker, 1 (USNM); Dry Fork, White River, 6400 ft., 3 (AMNH); Piceance, 15 (USNM); *Yellow Creek, Piceance,* 2 (USNM); Douglas Creek, 5 (USNM); Little Hills Experiment Station, 31 mi. SW Meeker, 6100 ft., 1 (CSU). GARFIELD COUNTY: 7 mi. W Rifle, 5300 ft., 1 (CU); East Salt Creek, 6 (USNM); *1/2 mi. E Grand Valley,* 1 (FMNH); 12 mi. SE Rifle, 1 (FMNH); Salt Creek, 2 (USNM). EAGLE COUNTY: 5 1/2 mi. W Gypsum, 1 (CSU); 11 mi. S Gypsum, 6200 ft., 2 (CSU). GRAND COUNTY: Carter Creek, 3 (USNM); *Antelope Creek,* 1 (USNM); *Muddy Creek,* 1 (USNM); Troublesome, 1 (USNM); *Gore Range, near Kremmling,* 1 (USNM); Kremmling, 2 (USNM); *Lookout, Kremmling,* 1 (USNM); Battle Creek, 11 (USNM). BOULDER COUNTY: Sixmile Canyon, off Lefthand Canyon, 1 (CU); Boulder, 6 (USNM). MESA COUNTY: Crevasse, 1 (USNM); Pine River, Mesa, 6 (USNM); *Beaver Creek, Mesa,* 3 (USNM); Grand Mesa, 2 (USNM); Glade Park, 3 (USNM); Unaweep Canyon, 1 (USNM). PARK COUNTY: *3 mi. W South Park [perhaps South Fork, Rio Grande County]*, 1 (USNM); Tarryall P. O., 16 (USNM); Howbert, 8570 ft., 2 (WC); Spinney, 1 (USNM); 5 mi. E Guffey, 1 (CU); Rye Slough, 4 (USNM). DELTA COUNTY: Cedaredge, 1 (USNM); Austin, 8 (USNM); near Crawford, 1 (WC); *no locality other than county*, 1 (USNM). GUNNISON COUNTY: Crested Butte, 2 (WC). CHAFFEE COUNTY: Buena Vista, 1 (DMNH); Salida, 1 (USNM). EL PASO COUNTY: 20 mi. S Colorado Springs, 2 (WC). MONTROSE COUNTY: 2 mi. N Montrose, 2 (USNM); Coventry, 5 (2 USNM, 3 WC). SAGAUCHE COUNTY: Sargents, 2 (USNM); Clark's Ranch, near Cochetopa Pass, 1 (USNM); Russell Springs, 15 (USNM). FREMONT COUNTY: Bear Creek, 8 mi. below Salida, 1 (WC). CUSTER COUNTY: Junkins Park, 12 mi. E Westcliffe, 1 (SCSC). MINERAL COUNTY: "Goose Creek, Monte Vista," 5 (USNM). RIO GRANDE COUNTY: Monte Vista, 12 (USNM); *"Big Spring Creek, Monte Vista,"* 5 (USNM). ALAMOSA COUNTY: 15 mi. NE Mosca, 6 (USNM). CONEJOS COUNTY: La Jara, 7 (USNM); *near La Jara*, 2 (USNM); *7 mi. E La Jara*, 1 (USNM); *Jim Creek, W of La Jara Reservoir*, 1 (USNM); 2 mi. E La Jara Reservoir, 1 (USNM); *Bountiful*, 1 (USNM); Cenicro, 25 mi. SE La Jara, 5 (USNM); *Rio Grande*, 2 (USNM). COSTILLA COUNTY: San Acacio, 7737 ft., 1 (WC). County unknown: *Mosca Lake*, 6 (USNM); *Purdue Camp*, 15 (USNM).

Additional records (Jackson, 1951:283, unless otherwise noted): MOFFAT COUNTY: Great Divide Basin (Young, 1951:73); Little Snake River; Greystone; Lily; Maybell (Cottam, 1942:450). JACKSON COUNTY: Walden. LARIMER COUNTY: *Fossil Creek* (Markham, 1907:146); Longs Peak region (Warren, 1927b:149). RIO BLANCO COUNTY: 15 mi. W Rangely; *Little Beaver Creek* (Felger, 1910:133); *Baxter Springs; 23 mi. E Dragon, Utah.* GARFIELD COUNTY: Rifle Gap (Felger, 1910: 133); Rifle. EAGLE COUNTY: W side Tennessee Pass (Young, 1951:53). GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:224). MESA COUNTY (P. H. Miller, 1964:76): Glade Park, sec. 16, T. 12 S, R. 102 W, 6800 ft.; *Piñon Mesa, 4 mi. S, 1 mi. E Glade Park Store.* PARK COUNTY: *Montgomery* (Blake and Blake, 1969:37); *Quartzville* (Blake and Blake, *loc. cit.*); Rich Creek (Young, 1951:101). GUNNISON COUNTY: *NE slope Gothic Mountain* (Findley and Negus, 1953:237). MONTROSE COUNTY: *Redvale* (Young, 1951:101). SAGUACHE COUNTY: near Saguache (Young, *op. cit.*:99).

Canis latrans mearnsi Merriam

Canis mearnsi Merriam, Proc. Biol. Soc. Washington, 11:30, 15 March 1897; type locality, Quitobaquito, Pima Co., Arizona.

Canis latrans mearnsi, Nelson, Proc. Biol. Soc. Washington, 45:224, 26 November 1932.

Distribution in Colorado.—Drainage of San Juan River, extreme southwestern part of state (Fig. 89).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa.

Measurements.—Selected cranial measurements of two males from Montezuma County are: condylobasal length, 183.0, 180.4; zygomatic breadth, 99.7, 94.0; interorbital constriction, 33.3, 32.5; mastotid breadth, 63.7, 58.8; length of nasals, 78.0, 75.4; length of maxillary toothrow, 82.8, 82.2. For additional measurements, see Jackson (1951:299).

Records of occurrence.—Specimens examined, 36, distributed as follows: DOLORES COUNTY: Dove Creek, 2 (USNM); *Chico Creek*, 2 (USNM). MONTEZUMA COUNTY: Dolores, 1 (USNM); McElmo, 2 (USNM); *1 1/2 mi. E Waters Cabin, 6490 ft., Mesa Verde National Park*, 1 (KU); Square Tower House, 1 (KU). LA PLATA COUNTY: *Animas River*, 1 (USNM); Durango, 3 (USNM); *near Durango*, 1 (USNM); *La Plata River, near Durango*, 2 (USNM); Florida, 1 (USNM); *Florida River*, 13 (USNM); *Adelaide, Florida River*, 1 (USNM); *Los Piños River*, 1 (USNM); Beaver Creek, [near] Durango, 4 (USNM). ARCHULETA COUNTY: SW base Pagosa Peak, 8000 ft., 2 (USNM).

Canis lupus

Gray Wolf

Canis lupus formerly ranged throughout boreal, temperate, and some subtropical parts of North America. Due to disruption of its range by settlement and active eradication programs, the gray wolf has been extirpated over most of its former range in conterminous United States. S. P. Young (1944b) detailed the history of this extirpation. Eastern Colorado was within the range of operations of professional wolf-poisoners, and wolves were removed from the eastern part of the state along with the bison in the latter part of the Nineteenth Century. In mountain valleys and on the Western Slope, wolves persisted somewhat longer, but were reduced in number by steady pressure of trapping, poisoning, shooting, and den-hunting. Lechleitner (1969:171) knew of no authentic reports of wolves in Colorado later than 1935. Warren (1942:97) noted that eight wolves were reported from the National Forests of Colorado in 1936, but that only two were reported in 1938. Young

(1944b:58) mapped Colorado as part of a vast region from which wolves had been eradicated by 1941. E. Wilkinson, a Monte Vista taxidermist and frequent contributor to outdoor magazines, noted (1965) that the last wolf killed in Conejos County was taken in 1943.

In the summer of 1969, I talked at some length with a former bounty-hunter from Delta who had worked from the Uncompahgre Plateau north to the Piceance Creek drainage. He had begun work in the 1920's, and noted that wolves were mostly gone by the time he started, his income being primarily from coyotes and bears. However, he did claim that he and another trapper had seen a wolf in Saguache Park above Parlin in 1967. My informant obviously was a keen observer, but, however much I would like to believe his report, I regard it as questionable in the absence of other evidence.

J. A. Allen (1874:54) noted that wolves were scarce in South Park in 1871. Previously they were said to have been abundant. By 1871, the bison of South Park were reduced to a meager remnant of their former numbers, and that may have been a factor in the demise of wolves there. V. Bailey (1907) gave detailed notes on the relationship of wolves to livestock in Colorado. Goldman (1944) reviewed subspecies of North American wolves. Jolicouer (1959) noted discordant infraspecific variation in *C. lupus.*

Canis lupus nubilis Say

Canis nubilis Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:169, 1823; type locality, Engineer Cantonment [approximately 2 mi. E Fort Calhoun, Washington Co.], Nebraska.

[Canis] lupus nubilus, Richardson, Fauna Boreali-Americana, p. 69, 1829.

Distribution in Colorado.—Extinct; formerly widespread on plains of eastern one-third of state and in San Luis Valley (Fig. 90).

Comparison.—From *C. l. youngi,* the subspecies of the highlands to the west, *C. l. nubilus* differed in smaller average size externally and cranially; upper parts grayer (less suffused with buff); supraoccipital narrower, the inion projecting farther posteriorly over the foramen magnum, and tending to develop a descending terminal hook (Goldman, 1944:443).

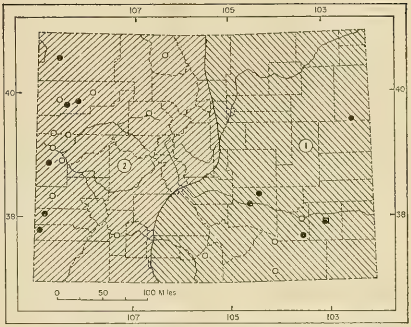


FIG. 90. Distribution of *Canis lupus* in Colorado. 1. *C. l. nubilus.* 2. *C. l. youngi.* For explanation of symbols, see p. 9.

Measurements.—Total length of an adult male from Douglas, Wyoming, 1982; height at shoulder, 940 (Goldman, 1944:443). Representative cranial measurements of a male and a female from Bent County (Goldman, *op. cit.*:492, 502) are: condylobasal length, 239.8, 213.0; zygomatic breadth, 133.2, 124.6; breadth of rostrum, 43.9, 43.4; postorbital breadth, 42.2, 39.5; crown length of maxillary toothrow, 106.2, 97.0.

Remarks.—Specimens from Pueblo County are large for *C. l. nubilus,* and were referred by Goldman (1944:463) to *C. l. youngi.* In some cranial details (for example, conformation of the supraoccipital), the specimens agree with *nubilus,* to which subspecies they are herein referred. Perhaps the individuals represent intergrades between *nubilus* and *youngi.* The supposed zone of intergradation between the two subspecies in Colorado is poorly known, the only large series of specimens being from the western and southeastern parts of the state, possibly reflecting a differential abundance of wolves in Colorado early in the present century when the Bureau of Biological Surveys accumulated series of skulls for systematic study.

Records of occurrence.—Specimens examined, 23, distributed as follows: YUMA COUNTY: "Republican Fork" [of South Platte River], 1 (USNM). PUEBLO COUNTY: 20 mi. NE Pueblo, 2 (USNM);

Pueblo, 2 (USNM). OTERO COUNTY: Higbee, 3 (USNM). BENT COUNTY: no locality other than county, 15 (USNM).

Additional records: PUEBLO COUNTY: *SE of Pueblo* (Young, 1944b:62). OTERO COUNTY: Bent's Fort (Young, *loc. cit.*). COSTILLA COUNTY: Fort Massachusetts (Goldman, 1944:444). LAS ANIMAS COUNTY: 11 mi. N Thatcher (Goldman, *loc. cit.*); *Bear Springs Mesa, about 40 mi. E Trinidad* (Young, 1944b:278); Butler Pasture, 40 mi. E Trinidad (Young, *op. cit.*:203).

Canis lupus youngi Goldman

Canis lupus youngi Goldman, Jour. Mamm., 18:40, 11 February 1937; type locality, Hart Draw, N slope of Blue Mountains, 20 mi. NW Monticello, San Juan Co., Utah.

Distribution in Colorado.—Formerly widespread in mountains, plateaus, and canyons of western two-thirds of state (Fig. 90).

Comparison.—For comparison with *C. l. nubilus*, see account of that subspecies.

Measurements.—Total lengths of an adult male from Eagle County and an adult female from Garfield County are, 1777, 1701; height at shoulder, 806, 724; weights (pounds), 125, 110. Representative cranial measurements of three males and mean (and extreme) cranial measurements of five females, all from east-central Colorado (Goldman, 1944) are: condylobasal length, 248.5, 242.7, 242.9, 227.72 (218.5-233.5); zygomatic breadth, 148.0, 139.8, 142.4, 130.00 (127.2-131.7); breadth of rostrum, 48.2, 46.8, 47.1, 41.34 (40.0-42.9); interorbital constriction, 51.5, 50.7, 46.1, 43.74 (39.7-49.7); postorbital breadth, 45.4, 42.6, 37.7, 38.58 (36.0-39.9); crown length of maxillary toothrow, 110.3, 109.9, 110.9, 103.62 (99.9-106.7).

Records of occurrence.—Specimens examined, 14, distributed as follows: MOFFAT COUNTY: Douglas Spring, 2 (WC). RIO BLANCO COUNTY: Sulphur, 1 (USNM); Piceance, 3 (USNM); *Turman's Creek*, (not found), 1 (USNM). GARFIELD COUNTY: West Creek, 2 (USNM). MESA COUNTY: Glade Park, 2 (USNM); *Black Ridge, Glade Park*, 1 (USNM). SAN MIGUEL COUNTY: Stone Cabin, Dry Creek Basin, 1 (WC). DOLORES COUNTY: Chico Creek, 1 (USNM).

Additional records (Goldman, 1944:462-463), unless otherwise noted): JACKSON COUNTY: North Park (Young, 1944b:364). RIO BLANCO COUNTY: White River (Young, *op. cit.*:79); *SW of Meeker* (Young, *op. cit.*:83); Cathedral Bluffs (Young, *op. cit.*:278). GARFIELD COUNTY: divide between Rifle and Meeker (Felger, 1910:145); Salt Creek, about 22 mi. N Fruita. EAGLE COUNTY: Castle Peak, 15 mi. NE Eagle. MESA COUNTY: 16 mi. W De Beque (Young, *op. cit.*:273); near Fruita (Young, *op. cit.*:96); Unaweep Canyon, near Whitewater (Young, *op. cit.*:278). MONTROSE COUNTY: 25 mi. NW Redvale. HINSDALE COUNTY: headwaters of Rio Grande (Young, *op. cit.*:173).

Vulpes vulpes

Red Fox

Occurring over much of North America north of Mexico, the red fox is primarily a mammal of wooded regions, and is mostly absent from the more open parts of the Great Plains. In Colorado, the red fox is generally distributed in the mountains and occurs locally on the plains of the northeastern part of the state, particularly in irrigated country. *Vulpes vulpes* may be locally abundant in the mountains and in the wetlands surrounding irrigation reservoirs along the western edge of the Colorado Piedmont, from Denver northward to about Wellington. In the eastern part of the state, reports are available only from Logan and Yuma counties. Lechleitner (1969: 172) stated that ". . . the red fox now appears to occur throughout the state," but that statement probably is somewhat optimistic. There are no reports of the species from the lower Arkansas Valley.

The status of the red fox on the eastern plains is in need of critical study. It is not known whether the population there has resulted from a westward invasion by foxes from the east or an eastward movement on the part of animals from the mountains. The former pattern of dispersal is common. Hoffmann *et al.* (1969:593) discussed the spread of the red fox in Montana since 1950. Study also is needed of the influence on the native population of feral foxes escaped or released from fur farms. Hogue (1958) noted an instance of release of foxes from a fur farm on Willow Creek Pass; that same article discussed changes in populations of foxes with changes in trapping pressure.

J. A. Allen (1874:54) discussed color phases of *V. vulpes* in South Park. Of a series of about 35 skins from near Montgomery, one was melanistic and the remainder were about half red and half of the "cross" phase. Melanistic ("silver") foxes seem never to have been abundant in native populations. Coues and Yarrow (1875:55) reported a melanistic individual from Los Piños [=Bayfield], La Plata County, and Warren (1942:88) reported a silver fox from Cumbres Pass, Conejos County. Cross-foxes are considerably less abundant than the red phase. Among the few skins seen by me, only one was of a cross-fox, that from a place 3 mi. S of Colorado Springs.

Vulpes vulpes, as other foxes, was long considered a predator under Colorado law and thus afforded no legal protection. Under hunting regulations for the 1970 season, the red fox is regarded as a "non-game mammal." Licensed hunting is allowed throughout the year without limit on daily bag or possession. That same regulation applies categorically to the following list of mammals: "Raccoon, Coyote, Gray Fox, Red Fox, Bobcat, Jackrabbit, Skunk and Ground Squirrel."

Churcher (1959) compared North American and Eurasian red foxes, concluding that the populations represent a single holarctic species, *Vulpes vulpes* Linnaeus.

Vulpes vulpes macroura Baird

Vulpes macrourus Baird, *in* Stansbury, Exploration and survey of the valley of the Great Salt Lake of Utah, Appendix C, p. 309, June 1852; type locality, Wasatch Mountains, near Great Salt Lake, Utah.

Vulpes vulpes macroura, Anderson, Univ. Kansas Publ., Mus. Nat. Hist., 14:58, 24 July 1961.

Distribution in Colorado.—Generally distributed in mountainous parts of state; plains of northeastern Colorado (Fig. 91).

Comparison.—From *V. v. regalis*, the subspecies of the northern Great Plains, *V. v. macroura* differs in generally smaller size, relatively longer tail, and paler (more yellowish and less reddish) color.

Measurements.—External and cranial measurements of two males and two females from near Crested Butte, and of two males from southwestern Weld County, are: 1054, 1092, 1038, 1038, 1180, 1230; 410, 463, 388, 388, 460, 470; 171, 179, 171, 171, 160, 164; —, —, —, —, 84, 89; condylobasal length, 142.6, 146.4, 130.8, 133.9, 143.1, 141.8; zygomatic breadth, 76.7, 76.9, 69.7, 71.8, 76.2, 72.9; interorbital constriction, 26.2, 26.7, 24.9, 24.3, 27.0, 27.6; length of nasals, 56.8, 57.5, 51.8, 52.4, 56.2, 55.7; length of maxillary toothrow, 65.3, 66.8, 62.4, 62.2, 64.9, 65.9. The males from Weld County weighed 9 pounds, 6 ounces, and 10 pounds, 4 ounces.

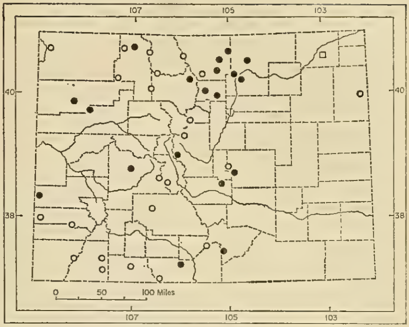


FIG. 91. Distribution of *Vulpes vulpes macroura* in Colorado. For explanation of symbols, see p. 9.

Remarks.—In the absence of specimens, the subspecific status of the red fox of northeastern Colorado is not known. If the population represents natural invasion (or reinvasion) from the east, *V. v. regalis* is the subspecies to be expected.

Records of occurrence.—Specimens examined, 40, distributed as follows: ROUTT COUNTY: Hahn's Peak, 2 (DMNH). LARIMER COUNTY: Cobb Lake Management Area, 1 (CSU); *3 mi. N Fort Collins,* 1 (CSU); *10 mi. N Timnath,* 1 (CSU); *1 mi. N Fort Collins,* 1 (CSU); *Lindenmeier Lake,* 1 (CSU); *1/4 mi. NW Iverson's Dairy [junction U.S. Highway 287 and N Shields Street, NW of Fort Collins],* 1 (CSU); *1 mi. NE Fort Collins,* 1 (CSU); 3 mi. W Fort Collins, 1 (CSU); *4 mi. E Fort Collins,* 1 (CSU); *5 mi. NNE Timnath,* 1 (CSU); *1 mi. NE Timnath,* 1 (CSU); *1 mi. E Warren Reservoir, 5000 ft.,* 1 (CSU); Arkins, 1 (USNM). WELD COUNTY: 7 mi. N Greeley, 1 (CSC); *3 mi. E Windsor,* 1 (CSU); *3 mi. S, 1 mi. E Windsor,* 1 (CSU); 1/2 mi. N, 1 mi. E Johnstown, 2 (CSU); 5 mi. E Milliken, 1 (CSU). RIO BLANCO COUNTY: Piceance, 1 (USNM); Rio Blanco, 1 (USNM). GRAND COUNTY: W side of Rocky Mountain National Park, 1 (RMNP). BOULDER COUNTY: Ward, 5 (USNM); Boulder, 1 (CU). PARK COUNTY: 25 mi. W Hartsel, 1 (USNM). GUNNISON COUNTY: Decker's Ranch, near Crested Butte, 4 (WC). EL PASO COUNTY: 3 mi. S Colorado Springs, 1 (SCSC). MONTROSE COUNTY: near Utah boundary, 1 (USNM). FREMONT COUNTY: Phantom Canyon, 1 (SCSC). HUERFANO COUNTY: 12 mi. W La Veta, 1 (CU). CONEJOS COUNTY: La Jara, 1 (USNM).

Additional records (Cary, 1911:174, unless otherwise noted): MOFFAT COUNTY: ". . . around

Mount Collom and Zenobia Peak." ROUTT COUNTY: Elkhead Mountains; Williams River Mountains; Gore Range. JACKSON COUNTY: Park Range; Medicine Bow Range; Rabbit Ears Mountains. LARIMER COUNTY: Estes Park. LOGAN COUNTY: no precise locality (Remington, 1963—see remarks above). GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53); *Grand Lake region.* SUMMIT COUNTY: Gray's Peak, about 12,000 ft.; Breckenridge (Warren, 1942:87). YUMA COUNTY: vicinity of Wray (F. A. Scarpella, Division of Game, Fish and Parks, personal communication, 1968—see remarks above). PARK COUNTY: Montgomery (J. A. Allen, 1874:54). GUNNISON COUNTY: near Tincup. CHAFFEE COUNTY: near St. Elmo. EL PASO COUNTY (Warren, 1942:88): Garden of the Gods, 6000 ft.; *Turkey Creek.* MONTROSE COUNTY: *Uncompahgre Plateau.* SAN MIGUEL COUNTY: Dolores River between mouths of Disappointment and Paradox creeks. SAGUACHE COUNTY: Cochetopa Hills. CUSTER COUNTY: W of Westcliffe. DOLORES COUNTY: near Lone Cone. HUERFANO COUNTY: La Veta Pass. LA PLATA COUNTY (Coues and Yarrow, 1875:54-55): N of Vallecito; La Plata Mountains; Los Piños [=Bayfield]. ARCHULETA COUNTY: N of Pagosa Springs. CONEJOS COUNTY: Cumbres Pass (Warren, 1942: 88). COSTILLA COUNTY: Sierra Blanca.

Vulpes macrotis

KIT FOX

The kit fox and swift fox are apparent vicariads. Similar in natural history and appearance, the former species occupies the desert Southwest, the latter the Great Plains. Lechleitner (1969:173) treated both as a single species, *Vulpes velox*. The ranges of the two kinds approach each other in western Texas and eastern New Mexico, but until intergradation is demonstrated, the conservative course is to regard the two as full species.

The ecology of *Vulpes macrotis* in *Colorado* has not been studied although P. H. Miller (1964:80) noted that the species is an inhabitant of rims and open sagebrush and juniper communities in Colorado National Monument.

Vulpes macrotis arsipus Elliot

Vulpes arsipus Elliot, Field Columbian Mus., Publ. 87 (Zool. Ser. 3), 14:256, 7 January 1904; type locality, Dagget, San Bernardino Co., California.

Vulpes macrotis arsipus, Grinnell, Proc. California Acad. Sci., ser. 4, 3:287, 28 August 1913.

Distribution in Colorado.—Known only from western Mesa County (Fig. 92).

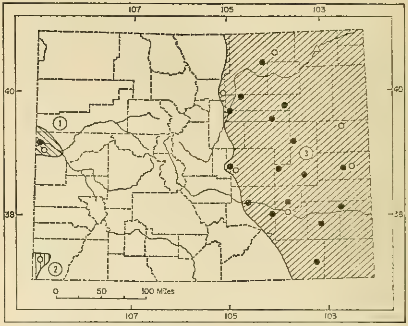


FIG. 92. Distribution of two species of foxes in Colorado. 1. *Vulpes macrotis arsipus.* 2. *V. m. neomexicana.* 3. *Vulpes velox velox.* For explanation of symbols, see p. 9.

Comparison.—From *V. m. neomexicanus,* the subspecies of extreme southwestern Colorado, *V. m. arsipus* differs primarily in notably smaller size.

Measurements.—External measurements of a male and a female (CU 7579, 7580) from Mesa County are: 759, 790; 250, 258; 126, 122; 84, —. Selected cranial measurements of the above-mentioned individuals, followed by the mean (and extremes) of eight males and of seven females, all from Nye and Churchill counties, Nevada, are: condylobasal length, 107.9, 107.0, 107.46 (105.0-115.8), 104.21 (98.9-108.0); zygomatic breadth, 60.6, 57.6, 59.20 (57.9-60.4), 55.68 (54.1-58.3); interorbital constriction, 21.4, 21.3, 21.09 (19.8-21.8), 20.77 (19.4-21.9); postorbital constriction, 21.3, 20.5, 20.95 (19.8-22.5), 21.46 (19.1-23.0); length of nasals, 39.7, 38.9, 38.50 (36.3-42.4), 36.33 (33.9-38.4); length of maxillary toothrow, 49.9, 49.8, 50.64 (47.6-54.4), 48.13 (46.0-50.1).

Remarks.—I agree with Miller and McCoy (1965) that available specimens of *V. macrotis* from Mesa County are more similar morphologically to named populations of the Lower Colorado River basin than to *V. m. neomexicana* of the San Juan drainage to the south. Three subspecies of small, pale kit foxes have been recognized in the Great Basin and Mojave Desert. *Vulpes m. arizonensis* Goldman was considered a synonym of *V. m.*

arsipus by Hall and Kelson (1959:858); *V. m. nevadensis* Goldman was recognized as barely separable from *V. m. arsipus* by Hall (1946: 236). Durrant (1952:403) maintained the distinction between *arsipus* and *nevadensis*, referring all kit foxes from Utah to the latter subspecies. *Vulpes m. arsipus* does not differ appreciably from *V. m. nevadensis* in size; based on slight differences in color as noted by Hall (*op. cit.*:237), Coloradan specimens are judged by me to represent *V. m. arsipus*, in agreement with Miller and McCoy (1965).

Records of occurrence.—Specimens examined, 2, as follows: MESA COUNTY: 3 mi. S Stateline Store, 2 (CU).

Additional records (P. H. Miller, 1964:78-79): MESA COUNTY: *1/4 mi. W Red Canyon View, Colorado National Monument* (sight record); junction Rim Rock Drive and West Glade Park Road, 6479 ft.

Vulpes macrotis neomexicana Merriam

Vulpes macrotis neomexicanus Merriam, Proc. Biol. Soc. Washington, 15:74, 22 March 1902; type locality, Baird's Ranch, E side San Andres Mountains, Dona Ana Co., New Mexico.

Distribution in Colorado.—Known only from western Montezuma County (Fig. 92).

Comparison.—For comparison with *V. m. arsipus*, see account of that subspecies.

Measurements.—Cranial measurements of an adult male from Montezuma County (Egoscue, 1964), a male (KU 82818) from Presidio County, Texas, and the holotype (USNM 98646, a male) include: condylobasal length, 117.8, 116.4, 114.1; zygomatic breadth, 59.7, 65.5, 64.0; interorbital constriction, 19.7, 24.0, —; postorbital breadth, —, 21.3, 19.6; length of nasals, 43.2, 42.5, —; mastoid breadth, —, 40.5, 39.5; length of maxillary toothrow, —, 53.4, 52.4.

Remarks.—I have examined no specimens from Colorado of this subspecies. Cranial measurements reported by Egoscue (1964) support his reference of specimens from Montezuma County to *neomexicana*. V. Bailey (1932:298) reported the subspecies from San Juan County, New Mexico.

Records of occurrence.—Specimens examined, none.

Additional record: MONTEZUMA COUNTY: McElmo Canyon (Egoscue, 1964:40).

Vulpes velox

Swift Fox

The swift fox formerly occupied most of the Great Plains, from western Texas northward to Alberta. Over much of its range the species has been greatly reduced in numbers, a casualty—usually inadvertent—of predator-control programs. In Colorado, *Vulpes velox* occurred generally over much of the eastern part of the state. Coues (1879:219) noted: "This is an abundant animal in Colorado, living in burrows on the prairie." Today the species occurs sparingly over most of its former range in the state, but is more abundant in the Arkansas River drainage.

No published study of the swift fox in Colorado has been made; Kilgore (1969) reported on an excellent ecological study of *V. velox* in the Oklahoma Panhandle.

Vulpes velox velox (Say)

Canis velox Say, *in* James, Account of an expedition from Pittsburgh to the Rocky Mountains . . . , 1:487, 1823; type locality, South Platte River, Logan Co., Colorado.

Vulpes velox, Audubon and Bachman, The viviparous quadrupeds of North America, 2:13, 1851.

Distribution in Colorado.—Open plains of eastern part of state (Fig. 92).

Measurements.—External measurements of an adult male (CSU 10453) from near Limon, Lincoln County, are: 700, 243, 115, 60. Representative cranial measurements of a male from Prowers County (CU 6021), two males from Bent County (USNM 187994-95), and a female from Baca County (USNM 213112), are, respectively: condylobasal length, 114.5, 108.7, 109.7, 113.3; zygomatic breadth, 63.9, 63.6, 64.9, 63.0; interorbital constriction, 24.7, 24.0, 23.5, 24.0; postorbital constriction, 22.6, 25.2, 21.9, 22.5; length of nasals, 41.2, 36.1, 38.3, 41.7; length of maxillary toothrow, 54.1, 51.6, 51.8, 52.7.

Remarks.—Cary (1911:176) admitted a record of *V. velox* from Jackson County as follows: "Mr. W. H. Graham, of Spicer, says he has met with the species but once during a long residence in North Park. In 1893 he shot two near their den, which was on an open sandy slope near Arapahoe Creek, in the southern part of the park." The locality is not mapped in Fig. 92. Long (1965:681) reported specimens from the North Platte Valley in Carbon County, Wyoming; however, considerable ecological change occurs southward along the North Platte from those localities of definite record into Jackson County, Colorado. I am skeptical of the record cited by Cary and am unwilling to admit it without some qualification.

Hall and Kelson (1959:859) mapped the range of *V. velox* as extending into northwestern Colorado. Whereas habitat there seemingly is suitable, there is no concrete evidence of the species in that part of the state. Long *(loc. cit.)* ascribed to the swift fox a range in Wyoming more restricted than that shown by Hall and Kelson *(loc. cit.)*, and referred all specimens known to him from Wyoming to *V. v. velox*.

Long and Long (1964) reported specimens from 25 mi. NW of Estelene. Estelene is located in Baca County, just east of Carrizo Mountain, about sec. 16, T. 33 S, R. 50 W.

Records of occurrence.—Specimens examined, 26, distributed as follows: WELD COUNTY: 8 mi. E Cornish, 1 (WC). ADAMS COUNTY: Brighton, 1 (DMNH); Simpson, 5 (DMNH). DENVER COUNTY: Denver, 1 (AMNH). ARAPAHOE COUNTY: Deer Trail, 1 (DMNH). LINCOLN COUNTY: Limon, 1 (CSU); 5 1/2 mi. E Rush, 1 (FHSC); 30 mi. S Hugo, 1 (CSU). EL PASO COUNTY: W of Colorado Springs, 1 (AMNH); near Security, 1 (WC); *no locality other than county,* 2 (1 CSU, 1 FWS). CHEYENNE COUNTY: Firstview, 2 (KU). PUEBLO COUNTY: near Pueblo, 1 (USNM); 12 mi. SW Fowler, 1 (SCSC). CROWLEY COUNTY: no locality other than county, 1 (FWS). OTERO COUNTY: *no locality other than county,* 1 (CSU). BENT COUNTY: no locality other than county, 2 (USNM). PROWERS COUNTY: 3 mi. N Wiley, 1 (CU). LAS ANIMAS COUNTY: 25 mi. NW Estelene, 1 (USNM).

Additional records (Cary, 1911:176-178, unless otherwise noted): JACKSON COUNTY: *Arapahoe Creek, near southern end of North Park* (see remarks above). WELD COUNTY: near Keota. BOULDER COUNTY: 3 mi. NE Boulder. KIT CARSON COUNTY: near Tuttle. CHEYENNE COUNTY: Cheyenne Wells. CROWLEY COUNTY: *no precise locality* (Rapp, 1962:217). OTERO COUNTY: Rocky Ford (Elliot, 1907:415).

Urocyon cinereoargenteus

GRAY FOX

In Colorado, the gray fox occurs in areas of brush and in woodlands of pygmy conifers. The species is mostly restricted to the foothills of the Eastern Slope and to rough country at moderate elevations on the Western Slope. In southeastern Colorado, the gray fox occurs in comparable situations eastward to Baca County. The ranges of the gray fox and the red fox are more or less complementary in the state; I know of no records of *Urocyon cinereoargenteus* from higher parts of the mountains or from irrigated valleys of the northeastern part of Colorado.

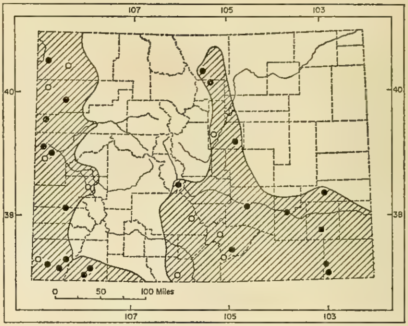


FIG. 93. Distribution of *Urocyon cinereoargenteus scottii* in Colorado. For explanation of symbols, see p. 9.

As is true of other kinds of foxes, the legal status of *Urocyon* in Colorado recently has been changed from that of "predator" to "nongame mammal" (see account of *Vulpes vulpes*).

Urocyon cinereoargenteus scottii Mearns

Urocyon virginianus scottii Mearns, Bull. Amer. Mus. Nat. Hist., 3:236, 5 June 1891; type locality, probably near Oracle, Pinal Co., Arizona (*fide* Goldman, 1938c).

Urocyon cinereo-argenteus scottii, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:253, 29 June 1895.

Distribution in Colorado.—Locally in rough, broken terrain at moderate elevations on either side of the mountains (Fig. 93).

Comparison.—From *U. c. ocythous,* the subspecies of the lower Missouri Valley and adjacent areas (as known to me by specimens from Douglas County, Kansas), *U. c. scottii* differs in smaller external and cranial size and paler (more buffy and grayish, less blackish) pelage.

Measurements.—External measurements of a male from western Baca County are: 940, 425, 135, 65. Selected cranial measurements of males from Douglas County, Colorado (CSU 8449), Rio Blanco County (CSU 10158), and Montezuma County (KU 76299), and a female from Montezuma County (KU 76300) are, respectively: condylobasal length, 117.2, 114.8, 114.9, 116.9; zygomatic breadth, 64.6, 64.2, 65.1, 64.1; interorbital constriction, 21.8, 23.2, 24.9, 22.9; postorbital constriction, 26.4, 25.5, 26.5, 25.0; mastoid breadth, 42.7, 44.0, 44.7, 43.2; length of nasals, 35.3, 42.5, 39.7, 38.4; length of maxillary toothrow, 50.4, 49.6, 47.8, 48.9.

Remarks.—I have seen no specimens of *U. cinereoargenteus* from the plains of northeastern Colorado, but *U. c. ocythous* is to be expected there. Jones (1964:259) reported a specimen from Cheyenne County, Nebraska, less than 20 miles north of the Colorado boundary. In Kansas, the westernmost record of occurrence is at a place 3 mi. S and 5 mi. W of Arkansas City, Cowley County (Hall, 1955:184).

Records of occurrence.—Specimens examined, 35, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 2 (CU); *Hell's Canyon*, 1 (CU). LARIMER COUNTY: Estes Park, 1 (USNM). RIO BLANCO COUNTY: Little Hills Experiment Station, 35 mi. W Meeker, 1 (CSU). GARFIELD COUNTY: Trail Creek, 30 mi. N Mack, 2 (CM). BOULDER COUNTY: 5 mi. NW Lyons, 1 (CU). MESA COUNTY: 2 mi. S Mack, 1 (CM); 1 1/2 mi. above Grand Junction Entrance, Colorado National Monument, 1 (CNM); *no locality other than county*, 1 (USNM). DOUGLAS COUNTY: 1 mi. W Larkspur, 1 (CSU). CHAFFEE COUNTY: Salida, 3 (1 USNM, 2 WC). MONTROSE COUNTY: Coventry, 6 (1 SC, 4 USNM, 1 WC). PUEBLO COUNTY: 5 mi. S Pueblo, 1 (SCSC). KIOWA COUNTY: 8 mi. SE Haswell, 1 (CU). HUERFANO COUNTY: 3 mi. E La Veta, 1 (CU). OTERO COUNTY: Rocky Ford, 1 (FMNH). BENT COUNTY: no locality other than county, 1 (USNM). MONTEZUMA COUNTY: Mancos, 1 (SC); Ute Peak, 1 (DMNH); Square Tower House, Mesa Verde National Park, 2 (KU). LA PLATA COUNTY: *Florida River*, 1 (USNM); Animas River, 1 (USNM); Bondad, 1 (DMNH). BACA COUNTY: Carrizo School, 4800 ft., 1 (DMNH); Furnace [Furnish] Canyon, 1 (DMNH).

Additional records (Cary, 1911:176-178, unless otherwise noted): MOFFAT COUNTY: *Lily Park;* Lily. RIO BLANCO COUNTY: Rangely. JEFFERSON COUNTY: (probably near) Buffalo. MESA COUNTY (P. H. Miller, 1964:82): *Colorado National Monument, 5820 ft.; 1 1/4 mi. W East Entrance Ranger Station, 5000 ft.; below Coke Ovens View, 5700 ft.;* Piñon Mesa, 4 mi. S, 1 mi. W Glade Park Store, 7000 ft. MONTROSE COUNTY: within 3 mi. of Montrose. SAGUACHE COUNTY: 1 mi. N Crestone (sight record, DMA field notes, 22 July 1969). HUERFANO COUNTY: Gardner; Upper Cucharas Valley. CONEJOS COUNTY: E of Antonito. MONTEZUMA COUNTY: McElmo; *2 mi. N Headquarters, Mesa Varde National Park* (Anderson, 1961:59).

FAMILY PROCYONIDAE—RACCOON AND ALLIES

KEY TO SPECIES OF PROCYONIDAE IN COLORADO

1. Dark rings on dorsal surface of tail only; hard palate not extending posteriorly past last molar; condylobasal length less than 90	*Bassariscus astutus*
Dark rings on tail complete; hard palate extending posteriorly beyond last molar; condylobasal length greater than 110	*Procyon lotor*

Bassariscus astutus

RINGTAIL

The ringtail is an inhabitant of rough, broken terrain in southwestern United States and Mexico. In Colorado, suitable habitat is occupied on either side of the Continental Divide, but specimens examined all are from the Western Slope, at elevations to about 6000 feet. Rutherford (1954) reported an individual from about 8800 feet in Grand County, and Richards (1968) cited a record from 9200 feet near Taylor Park Dam, Gunnison County. The status of *Bassariscus astutus* in Colorado presently is under study by Mr. Richard E. Richards of Western State College of Colorado, Gunnison, in cooperation with the Division of Game, Fish and Parks (see Richards, *op. cit.*).

The ringtail is a fur-bearer under Colorado law, but the annually reported harvest is low. In reports for the years 1959 through 1967, the ringtail appeared in summaries for only three seasons, 1959 (three animals), 1960 (three), and 1967 (nine).

Bassariscus astutus arizonensis Goldman

Bassariscus astutus arizonensis Goldman, Proc. Biol. Soc. Washington, 45:87, 21 June 1932; type locality, Cosper Ranch, 12 mi. S Blue, 5000 ft., Greenlee Co., Arizona.

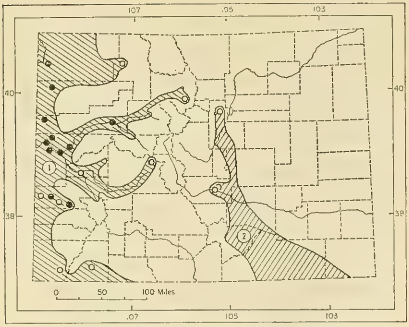


FIG. 94. Distribution of *Bassariscus astutus* in Colorado. 1. *B. a. arizonensis.* 2. *B. a. flavus.* For explanation of symbols, see p. 9.

Distribution in Colorado.—At lower elevations in canyons of Western Slope (Fig. 94).

Comparisons.—From *B. a. nevadensis,* the subspecies of Utah west of the Colorado and Green rivers and adjacent areas, *B. a. arizonensis* differs in: darker color of upper parts and blacker face, crown, and bases of ears; slightly broader rostrum; more widely spreading zygomatic arches; and anteriorly broader auditory bullae (after Goldman, 1932a:87).

From *B. a. flavus,* the subspecies of the Rio Grande drainage and the Eastern Slope of Colorado, *B. a. arizonenesis* differs in smaller external and cranial size and slightly grayer, less yellowish pelage.

Measurements.—External measurements of a young adult male and an adult female from Mesa County are: 655, 710; 317, 353; 58, 62; 35, —. Selected cranial measurements of a male from Moffat County and those of the above-mentioned two individuals are, respectively: condylobasal length, 74.9, 74.1, 69.8; zygomatic breadth, 49.5, 46.0, 40.8; interorbital constriction, 15.6, 14.9, 14.4; postorbital constriction, 16.3, 17.1, 18.8; mastoid breadth, 34.3, 34.9, 31.4; length of maxillary toothrow, 30.1, 29.4, 27.8.

Remarks.—Hall and Kelson (1959:880) ascribed to *Bassariscus astutus flavus* a range including much of western Colorado, but the basis for their subspecific assignment of ringtails from there is unknown to me. Cary (1911:192) cited Coloradan records under the subspecific name *flavus,* but at that time only two subspecies were recognized north of Mexico. The northern marginal record cited by Hall and Kelson *(loc. cit.)* is based on a broken skull (KU 29123) of an immature individual of unknown sex. The record from 2 1/2 mi. SW Mack (KU 29124) is based on a similar specimen. In my opinion, available specimens of *B. astutus* from the Western Slope clearly represent the small subspecies *B. a. arizonensis,* not *B. a. flavus* (as known to me by specimens from Texas and Coahuila).

Durrant (1952:413) was of the opinion that *B. a. arizonensis* and *B. a. nevadensis* intergrade in northeastern Utah. Farther south the Colorado River forms a strong barrier between the two subspecies (see Goldman, 1932a:88). Intergradation between *arizonensis* and *flavus* occurs in New Mexico according to Goldman *(loc. cit.).*

Records of occurrence.—Specimens examined, 14, distributed as follows: MOFFAT COUNTY: Castle Park, 2 (CU). RIO BLANCO COUNTY: 1 mi. N, 4 mi. E Rangely, 5500 ft., 1 (KU). GARFIELD COUNTY: Atchee, 30 mi. N Mack, 1 (CM); Glenwood Canyon, 6 mi. E Glenwood Springs, 1 (CSU). MESA COUNTY: 10 mi. N Loma, 1 (CU); Mack, 1 (CM); *2 1/2 mi. SW Mack, 4400 ft.,* 1 (KU); De Beque Cañon, SE of Cameo, 1 (CNM); Fruita Cañon, 1/2 mi. below Balanced Rock Pullout, Colorado National Monument, 1 (CNM); Grand Junction, 1 (FMNH); *near Grand Junction,* 1 (USNM). MONTROSE COUNTY: San Miguel Cañon, 5000 ft., 1 (WC); San Miguel Cañon, 5 mi. above Cottonwood Creek, 1 (WC).

Additional records (Richards, 1968:61-62, unless otherwise noted): ROUTT COUNTY: Hayden. GRAND COUNTY: Williams Fork River, 25 mi. S Hot Sulphur Springs, 8800 ft. (Rutherford, 1954: 442). MESA COUNTY: *1/4 mi. E Grand View, 5915 ft., Colorado National Monument* (P. H. Miller, 1964:86). DELTA COUNTY: near Delta (Warren, 1906:260). GUNNISON COUNTY: near Taylor Park Dam, about 9200 ft. MONTROSE COUNTY: Paradox Valley (Warren, 1942:49); near Nucla (Remington, 1955:46); *Coventry, 6800 ft.* (Warren, 1942: 49). SAN MIGUEL COUNTY: *near Norwood* (Remington, 1955:46). MONTEZUMA COUNTY: Mesa Verde National Park (Anderson, 1961:60). LA PLATA COUNTY: vicinity of Durango (Warren, 1906:260).

Bassariscus astutus flavus Rhoads

Bassariscus astutus flavus Rhoads, Proc. Acad. Nat. Sci. Philadelphia, 45:417, 30 January 1894; type locality, Texas.

Distribution in Colorado.—To an undetermined extent in suitable habitat in the foothills of Eastern Slope (Fig. 94).

Comparison.—For comparison with *B. a. arizonensis,* see account of that subspecies.

Measurements.—No Coloradan specimens of *B. a. flavus* were examined by me. Average (and extreme) measurements of six males and five females from Texas and Coahuila are: 796.5 (700-829), 726.6 (696-750); 385.3 (332-413), 357.2 (350-363); 70.5 (75-76), 67.0 (65-69); 50.6 (45-57), 52.0 (50-55); mean weight of four females, 948.4 (648-1125). Mean and extreme cranial measurements of nine males and five females from Texas and Coahuila include: condylobasal length, 78.53 (74.9-80.8), 75.38 (73.9-76.6); zygomatic breadth, 49.80 (46.8-54.4), 47.16 (44.1-49.6); interorbital constriction, 16.20 (14.4-17.7), 15.38 (15.1-17.0); postorbital breadth, 18.47 (15.7-20.9), 18.68 (16.6-21.8); mastoid breadth, 35.58 (33.3-37.9), 34.44 (33.3-35.0); length of maxillary toothrow, 30.35 (28.5-31.8), 29.68 (29.2-30.3).

Remarks.—Specimens of ringtails never have been reported from the San Luis Valley, although Warren (1906:260) admitted a report based on hearsay. The margins of the valley comprise considerable apparently suitable habitat, and the species is to be expected there. I have examined no specimens from the Eastern Slope, referring the few records from there to *B. a. flavus* solely on geographic grounds.

Records of occurrence.—Specimens examined, none.

Additional records: JEFFERSON COUNTY: 3 mi. W Golden (Richards, 1968:61). FREMONT COUNTY: Beaver Park (Warren, 1906:260); W of Cañon City (Richards, 1968:61).

Procyon lotor

Raccoon

Raccoons are abundant locally in Colorado, particularly in areas under irrigated cultivation. *Procyon lotor* is highly adaptable to environmental change and thrives in well-settled areas. Apparently populations have increased since settlement, and there probably also has been an actual expansion of the range with the new food resources provided by kitchen gardens and other plantings. Coues (1879) did not list the raccoon among mammals in the Maxwell Collection, although *P. lotor* presently is abundant in the vicinity of Boulder where that collection was made. Warren (1906:261) noted that raccoons were much more abundant north of the Platte-Arkansas Divide than to the south, and that he never had seen the species at Colorado Springs. The caretaker of Ramah Reservoir State Recreation Area in northeastern El Paso County informed me that raccoons had come into that area within the last 30 years, but presently were abundant.

The altitudinal limit of the raccoon in Colorado is not known. It is known to occur at lower elevations in Rocky Mountain National Park and is common about irrigated haylands in the Cache la Poudre drainage at least as high as Rustic and Manhattan.

Tester (1953) studied food habits of the raccoon in the South Platte Valley. Aside from that study, the natural history of the raccoon in Colorado has not been investigated.

The raccoon is regarded under Colorado law as a "non-game mammal"; previously it had been classed as a "predator." Nonetheless, some furs are sold commercially each year. Fur dealers reported buying an average of 391 skins over the 10-year period 1958-1967 (range, 193 in 1958 and 496 in 1967).

Despite the abundance of the raccoon at some localities in Colorado, the species is poorly represented in collections. As a result, accounts of subspecies beyond rely heavily on the taxonomic treatment of Goldman (1950).

Procyon lotor hirtus Nelson and Goldman

Procyon lotor hirtus Nelson and Goldman, Jour. Mamm., 11:455, 11 November 1930; type locality, Elk River, Sherburne Co., Minnesota.

Distribution in Colorado.—In suitable habitat on Eastern Slope (Fig. 95).

Comparisons.—From both *P. l. pallidus* and *P. l. mexicanus,* the subspecies *hirtus* differs primarily in markedly darker color, being more ochraceous to blackish and less grayish buff.

Measurements.—External measurements of a male and a female from Larimer County are: 753, 654; 281, 210; 124, 120; 61, 50; weights, 23 1/4 pounds, 19 1/5 pounds. External measusements of a male from Boulder and a female from near Cañon City are: 910, 853; 266, 244;

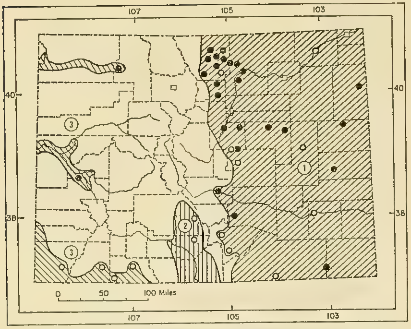


FIG. 95. Distribution of *Procyon lotor* in Colorado. 1. *P. l. hirtus.* 2. *P. l. mexicanus.* 3. *P. l. pallidus.* For explanation of symbols, see p. 9.

135, 114; 72, 61; weights, 19 1/2 pounds, —. Selected cranial measurements of the above-mentioned four individuals are, respectively: condylobasal length, 115.7, 113.4, 121.0, 116.3; zygomatic breadth, 75.0, 71.9, 79.0, 70.1; interorbital constriction, 27.3, 23.7, 23.6, 24.0; postorbital constriction, 25.0, 22.3, 22.3, 22.3; mastoid breadth, 65.6, 63.5, 66.2, 59.3; length of maxillary toothrow, 42.2, 44.3, 46.2, 43.5.

Records of occurrence.—Specimens examined, 52, distributed as follows: LARIMER COUNTY: 35 mi. [by road] NW Fort Collins, 1 (CSU); 11 mi. N Fort Collins, 1 (CSU); *10 mi. N Fort Collins,* 1 (CSU); Poudre Canyon, 35 mi. [by road] W Fort Collins, 1 (CSU); 10 mi. NW Fort Collins, 1 (CU); *3 mi. N Cement Plant, [N of] Fort Collins,* 1 (CU); *NE 1/4 sec. 35, T. 8 N, R. 70 W, 5200 ft.,* 1 (CSU); *1 mi. NE Fort Collins,* 1 (CSU); *2 mi. W Fort Collins,* 3 (2 CSU, 1 CU); Fort Collins, 3 (1 CSU, 2 CU); *1 3/10 mi. S Fort Collins,* 1 (CU); *3 mi. SW Fort Collins,* 1 (CSU); *foot of Dixon Dam,* 1 (CSU); *4 mi. SE Fort Collins,* 1 (CU); *8 1/2 mi. ESE Fort Collins,* 1 (CU); *Harmony,* 1 (CSU); 7 1/2 mi. SE Fort Collins, 1 (CSU); 11 1/2 mi. SW Fort Collins, 1 (CSU); Big Thompson Canyon, 1 (RMNP); Bear Lake Road, 1 (RMNP). WELD COUNTY: *1 1/2 mi. NE Timnath,* 1 (CU); 1 mi. E Severence, 1 (CSU); Greeley, 1 (CSC); *1 mi. S La Salle,* 1 (CSC); 3 mi. S, 1 mi. E La Salle, 1 (CSC). BOULDER COUNTY: 1 mi. S, 1 mi. E Lyons, 1 (RMNP); *6 mi. N Boulder,* 1 (RMNP); *Hayden's Lake [1 1/2 mi. E Valmont],* 1 (CU); Boulder, 3 (CU); *Boulder Creek, E of Boulder,* 1 (CU). YUMA COUNTY: Wray, 6 (DMNH). DOUGLAS COUNTY: *Cherry Creek,* 1 (DMNH); mouth of Platte Canyon, 1 (CU); 4 mi. NE Monument, 1 (CU). ELBERT COUNTY: 8 mi. W Agate, 1 (CU); 6 mi. N Riverbend, 1 (CU). KIT CARSON COUNTY: Tuttle, 1 (USNM). CHEYENNE COUNTY: Kit Carson, 1 (CU). FREMONT COUNTY: near Cañon City, 1 (CU). PUEBLO COUNTY: 22 mi. SW Pueblo, 1 (CSU). BACA COUNTY: 4 mi. SW Estelene, 1 (USNM).

Additional records (Cary, 1911:194, unless otherwise noted): LARIMER COUNTY: *Arkins;* Loveland. MORGAN COUNTY: no precise locality (Tester, 1953:500). LOGAN COUNTY: 2 mi. NE Sterling. SEDGWICK COUNTY: no precise locality (Tester, 1953:502). DOUGLAS COUNTY: Cherry Creek, near Parker (Bergtold, 1925:280). LINCOLN COUNTY: Big Sandy Creek, near Hugo. EL PASO COUNTY (Warren, 1942:47): Palmer Lake; Black Forest. HUERFANO COUNTY: Gardner; La Veta. BENT COUNTY: Arkansas River, Las Animas. LAS ANIMAS COUNTY: *Monument Lake;* Watervale.

Procyon lotor mexicanus Baird

Procyon hernandezii var. *mexicana* Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1): 215, 14 July 1858; type locality, Espía, Chihuahua.

Procyon lotor mexicanus, Mearns, Proc. Biol. Soc. Washington, 27:65, 20 March 1914.

Distribution in Colorado.—Suitable habitat in San Luis Valley (Fig. 95).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those races.

Measurements.—External and cranial measurements of two males and two females from western New Mexico and adjacent Arizona (Goldman, 1950:53) are: 895, 890, 840, 820; 365, 325, 305, 305; 121, 131, 125, 125; condylobasal length, 114.6, 115.6, 115.4, 110.9; zygomatic breadth, 77, 83.5, 78, 78.8; interorbital constriction, 24.2, 28.8, 24.2, 25.3; length of maxillary toothrow, 42.5, 42.7, 42.7, 43.6.

Remarks.—Specimens are not available from the San Luis Valley, and the population in that area is referred to *P. l. mexicanus* on geographic grounds and following Goldman (1950:24, fig. 1). Cary (1911:194) provided the only published reference to *P. lotor* in the San Luis Valley and supposed that "the raccoons which were reported . . . from the San Luis Lakes and the cottonwood-fringed streams along the western base of the Sangre de Cristo Range may have reached the San Luis Valley from the east by crossing over the low Mosca Pass from the head of the Huerfano River." In addition, the population probably is nearly or quite continuous with that to the south along the Rio Grande in New Mexico. One would expect on geographic grounds that animals from the San Luis Valley might prove to be intergrades between *P. l. mexicanus* and *P. l. hirtus*.

Records of occurrence.—Specimens examined, none.

Additional records: SAGUACHE COUNTY: 1 1/2 mi. N Crestone, 8050 ft. (sight record, DMA field notes, 18 July 1970). ALAMOSA COUNTY: San Luis Lakes (Cary, 1911:194).

Procyon lotor pallidus Merriam

Procyon pallidus Merriam, Proc. Biol. Soc. Washington, 13:151, 13 June 1900; type locality, New River, 6 mi. W Imperial, Imperial Co., California.

Procyon lotor pallidus, Grinnell, Univ. California Publ. Zool., 21:316, 27 January 1923.

Distribution in Colorado.—Drainages of major streams of Western Slope (Fig. 95).

Comparisons.—From *P. l. mexicanus*, the subspecies of the Rio Grande drainage, *P. l. pallidus* differs primarily in cranial details, in particular the narrower frontal region and longer average maxillary toothrow (see Goldman, 1950:54). For comparison with *P. l. hirtus*, see account of that subspecies.

Measurements.—No adults from Colorado were examined. External and cranial measurements of two males and two females from the Lower Colorado River, Arizona and California (Goldman, 1950:55), are: 950, 875, 855, 845; 405, 340, 295, 305; 135, 126, 128, 128; condylobasal length, 122.4, 120.6, 111.1, 119.6; zygomatic breadth, 79.1, 78.6, 77.8, 77.1; interorbital constriction, 25.3, 24.8, 25.5, 23.4; length of maxillary toothrow, 46.6, 43.7, 43.4, 41.7.

Records of occurrence.—Specimens examined, 2, distributed as follows: ROUTT COUNTY: 7 mi. W Hayden, 1 (CU). DELTA COUNTY: 3 mi. N, 3 mi. W Pea Green, 5000 ft., 1 (KU).

Additional records (Cary, 1911:194, unless otherwise noted). MONTEZUMA COUNTY (Anderson, 1961:59): 3 mi. WSW Mancos, 6700 ft.; Prater Grade, Mesa Verde National Park; near tunnel, Morfield Canyon, Mesa Verde National Park. LA PLATA COUNTY: "up the Los Piños as far as Bayfield." ARCHULETA COUNTY: "along the San Juan River to Pagosa Springs"; Arboles.

FAMILY URSIDAE—BEARS

KEY TO SPECIES OF URSIDAE IN COLORADO

1. Hind claws and foreclaws of approximately equal length; alveolar length of maxillary toothrow less than 110, M2 less than 1 1/2 times length of M1 .... *Ursus americanus*

   Foreclaws obviously longer than hind claws; alveolar length of maxillary toothrow greater than 110, M2 more than 1 1/2 times length of M1 .... *Ursus arctos*

Ursus americanus

BLACK BEAR

The black bear once ranged throughout forested parts of North America, from northern Alaska and Labrador, southward to Florida and central Mexico. I have no information that black bears ever occurred on the plains of eastern Colorado, but in the mountains the animals formerly were present in considerable numbers. Cary (1911:196) stated that D. Lantz "heard of one which was killed 20 miles south of Higbee in 1908." That would indicate that black bears ranged well to the eastward in the open woodlands of the southeastern part of the state. Today, bears occur throughout most mountainous parts of Colorado, from the foothills to treeline and occasionally above. Because of their omnivorous habits, black bears are less likely than some other large carnivores to avoid human settlement, unless they are directly molested. Open garbage dumps in smaller resort communities in the mountains frequently are good places to observe bears regularly. A dump between Estes Park and Allenspark was such a place in the early 1960's. In addition, black bears occur throughout more remote parts of the mountains, well away from settlement. For a comprehensive bibliography on *Ursus americanus*, see Tigner and Gilbert (1960).

Reliable estimates of the population of black bears in Colorado are not available. For many years, big game hunters could take a bear on an elk or deer license. A special bear license was instituted in 1955 and a season was established lasting April through September, although bear still could be taken during the regular big game season in October and November. In 1967 the bear coupon was removed from deer and elk licenses, resulting in a somewhat lower total bear kill.

Average annual reported bear harvest over the 15-year period 1955 to 1969 was 549 (range, 324 in 1956 to 728 in 1965). In 1969, 406 bears were taken by licensed hunters. In addition, the Branch of Predator and Rodent Control killed 72 bears that year. Unpublished estimates by the Division of Game, Fish and Parks indicate that the number of black bears killed illegally probably equals the total lawful harvest. In recognition of the fact that the annual kill was too large, some positive steps were taken to reduce the harvest in 1970, when cubs and females were given protection, and the period of sale of bear licenses was restricted so that kills of bears during the big game season might not be licensed *post facto*. The five counties with the highest total reported bear harvest over the years 1948 to 1964 were: Archuleta, Gunnison, Garfield, Mesa, and Montrose; among the counties on the Eastern Slope, only Larimer (tenth place) ranked among the top 16 bear-producing counties (unpublished data, Division of Game, Fish and Parks).

Ursus americanus amblyceps Baird

Ursus amblyceps Baird, Report of U.S. and Mexican Boundary Survey, 2(2):29, January 1859, type locality, Fort Webster, Gila River, Grant Co., New Mexico.

Ursus americanus amblyceps, V. Bailey, N. Amer. Fauna, 25:187, 24 October 1905.

Distribution in Colorado.—Formerly throughout mountainous parts of the state; presently generally distributed in less settled regions and common locally in the mountains (Fig. 96).

Comparison.—From *U. a. cinnamomum*, the subspecies of the Middle Rocky Mountains, *U. a. amblyceps* differs in slightly larger, relatively broader skull, shorter nasals, and relatively smaller cheekteeth.

Measurements.—External measurements of a young adult male from Boulder County are: 1549, 89, 235, 127. Selected cranial measurements of males from Eagle and Las Animas counties and an individual from El Paso County (judged by me to be a female on the basis of size) are: condylobasal length (measured with metric rule), 285, 293, 234; zygomatic breadth, —, 194.0, 147.8; interorbital constriction, 68.1, 75.6, 57.0; postorbital constriction, 70.2, 70.3, 61.2; mastoid breadth, 141.7, 149.0, 114.7; length of nasals, 75.6, 75.6, 68.3; length of maxillary toothrow, 97.5, 102.6, 87.3.

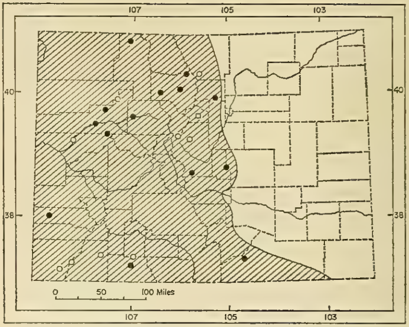


FIG. 96. Distribution of *Ursus americanus amblyceps* in Colorado. For explanation of symbols, see p. 9.

Remarks.—All Coloradan black bears are herein referred to a single subspecies, *U. a. amblyceps*. Durrant (1952:409) made detailed comparisons of bears from Utah and adjacent states, providing the best available treatment of differences between *amblyceps* and *cinnamomus*. With Durrant's comparisons in mind, I have examined series of specimens from Dotsero, Eagle County, and the vicinity of New Castle, Garfield County. Unfortunately, data on specimens in both of these series are incomplete. Both series are highly variable, but agree in general with *amblyceps* as characterized by Durrant (*loc. cit.*). Direct comparisons were made by me of Coloradan animals with specimens from northwestern Wyoming. Differences between these two samples are those noted above in the comparison. Other characters used by Durrant (*loc. cit.*) seem to me to be less reliable, particularly the conformation of the orbit and the frontal region. The range of variation seen in animals from west-central Colorado encompasses that of individuals from elsewhere in the state.

Records of occurrence.—Specimens examined, 37, distributed as follows: ROUTT COUNTY: 4 mi. NW Columbine, 1 (UMMZ). GARFIELD COUNTY: 18 mi. N New Castle, 1 (CU); Rifle, 1 (USNM); Divide Creek, 20 mi. S New Castle, 10 (USNM). EAGLE COUNTY: Dotsero, 7 (KU). GRAND

COUNTY: near Timber Creek, 1 (RMNP); Hot Sulphur Springs, 1 (USNM); Kremmling, 2 (USNM); *Silver Creek, Kremmling,* 1 (USNM). BOULDER COUNTY: Kossler's Lake, Green Mountain, 1 (CU). PARK COUNTY: Black Mountain, 2 (1 CU, 1 USNM); *Black Mountain Park,* 2 (CU). EL PASO COUNTY: N slope Pikes Peak, 1 (CU). FREMONT COUNTY: *Jackall Mountain* (not found), 1 (CU). SAN MIGUEL COUNTY: Dry Creek Basin, 1 (USNM). ARCHULETA COUNTY: Pagosa Springs, 3 (USNM). LAS ANIMAS COUNTY: Trujillo Creek, 1 (CU).

Additional records (Cary, 1911:195, unless otherwise noted): Estes Park region; *Fern Lake Lodge* (Welch, 1934:242). RIO BLANCO COUNTY: near Marvine Mountain. CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:232). MESA COUNTY (P. H. Miller, 1964:83): Alkali Creek, 1 mi. S De Beque; Piñon Mesa. PARK COUNTY: Montgomery, Mount Lincoln (Blake and Blake, 1969:37); South Park (J. A. Allen, 1874:54). MONTEZUMA COUNTY: 10 mi. E Mancos; Mesa Verde National Park (Anderson, 1961:59). LA PLATA COUNTY: Evans Sawmill, near Vallecito. ARCHULETA COUNTY: Pagosa Peak; *Pagosa Hot Springs* (Coues and Yarrow, 1875:67).

Ursus arctos

GRIZZLY BEAR

The grizzly bear once occupied a wide range in western North America, from Alaska south to Durango and eastward to Hudson Bay. Over much of that area the animals have been extirpated, except in more remote wilderness areas, National Parks, and other such sanctuaries. The grizzly bear is omnivorous, but it is difficult to imagine that many parts of its range were sufficiently productive to support the animals in any numbers. Yet, historical accounts frequently record the species as abundant in the early days. Brewer (1871: 221), who visited South Park in the summer of 1869, wrote: "Grizzly bears are quite common, and range to above 13,000 feet at this season. Six were seen above this altitude on Gray's Peak and Mt. Yale. . . ." However, J. A. Allen (1874:54) wrote of the same area: "Both black and cinnamon varieties occur in about equal numbers. The cinnamon variety is represented as averaging the larger, and as being the more dangerous. . . . Both vary greatly in color and size, and appear evidently to intergrade. The cinnamon . . . often passes for the grizzly, though not generally regarded as the 'true' grizzly."

Warren (1906:260) noted that "one often hears of Grizzly Bears being killed in [Colorado], but they almost always turn out to be some form of the Black Bear." Coues (1879: 221) described bears displayed in the Maxwell Collection at the Philadelphia Exposition of 1876 as follows: ". . . three varieties may be recognized. One of the largest is a true grizzly bear. . . . Others belong to the variety known as the 'cinnamon' bear. . . . Another specimen is the black bear, perhaps of an entirely different species from the rest."

With such a variety of testimony among trained observers, obviously records cited in popular accounts must be accepted with caution. Seemingly valid reports indicate that grizzly bears occurred not only in mountainous areas, but also eastward on the plains along wooded watercourses. Long's expedition encountered grizzlies at the base of Pikes Peak, in the eastern part of what is now Fremont County, and eastward near the mouth of the Purgatoire River (James, 1823). A grizzly bear is reported to have killed a member of Jacob Fowler's party near the mouth of the Purgatoire in 1821 (see Cary, 1911:201). On the Western Slope, most records are from wooded areas, but Cary (*op. cit.*:200) reported a specimen from Dry Creek Basin, San Miguel County, and the journals of T. J. Farnham (1839, 2:3) record a "grisly bear and two cubs" at the bend of the Yampa River between Lay and Fortification creeks in the 1830's. Both of the above-mentioned localities are in areas of open woodland and shrub communities.

Certain individual grizzly bears in Colorado were the basis for local legends and were given names. Warren (1942:41) reviewed tales of a number of those bears.

The present status of *Ursus arctos* in Colorado is not certain, but there are hopeful signs that some individuals remain in more remote parts of the San Juan Mountains. Three grizzlies have been killed in Hinsdale and Mineral counties in the last two decades. About 10 apparently reliable observations of animals or sign have been made in southern Colorado over that period. The last observation in the northern part of the state was made in 1920 in the Medicine Bow Range near Rocky Mountain National Forest, by Enos A. Mills (Tully, 1970).

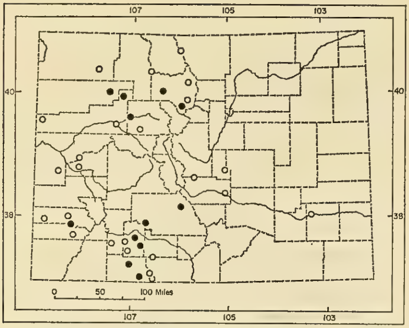


FIG. 97. Distribution of *Ursus arctos* in Colorado. For explanation of symbols, see p. 9.

As of this writing (1970), the U.S. Forest Service, the Division of Wildlife Services (formerly Branch of Predator and Rodent Control) of the U.S. Fish and Wildlife Service, and the Division of Game, Fish and Parks are cooperating on a study of the status of the grizzly bear in Colorado. The grizzly has been given the explicit protection of the law. Hopefully the action has been taken in time. The grizzly bear is a magnificent mammal, symbolic of a vanishing wilderness. Its extirpation would be an aesthetic loss to the state of Colorado.

Distribution in Colorado.—Formerly widespread in western Colorado and present to an undetermined extent on plains of eastern part of state; presently thought to persist only in remote parts of San Juan Mountains (Fig. 97).

Measurements.—Some external measurements (of doubtful reliability) of Coloradan grizzlies are given by Cary (1911:200) and also by Warren (1942:37). Selected cranial measurements are presented in table 23.

Remarks.—Merriam (1918) assigned Coloradan grizzly bears to five nominal species, of which four were named on the basis of holotypes collected within the state. The four nominal taxa with Coloradan type localities are:

Ursus shoshone Merriam, Proc. Biol. Soc. Washington, 27:184, 13 August 1914; type locality, Estes Park, Larimer Co., Colorado.

Ursus bairdi Merriam, Proc. Biol. Soc. Washington, 27:192, 13 August 1914; type locality, Blue River, Summit Co., Colorado.

TABLE 23

Selected cranial measurements of Coloradan grizzly bears.

Catalog number, USNM	Condylo-basal length[a]	Zygomatic breadth[a]	Interorbital breadth	Postorbital breadth	Alveolar length P4-M2	Length of maxillary toothrow
			Estes Park, Larimer County			
203185 ♂, young adult	335	228	77.3	65.9	73.6	123.2
			White River, Rio Blanco County			
22985 ♂, adult	335	223	77.1	71.7	80.5	133.2
			South Branch, Williams Fork of Colorado River, Grand County			
203178 ♀, young adult	——	178	64.4	62.8	71.5	115.9
			Blue River, probably in Summit County[b]			
203805 ♂?, adult	359	238	80.5	82.5	82.9	138.4
			S of Creede, Mineral County			
248537 ♀, adult	298	182	63.2	65.7	73.4	115.8
			Upper Saguache Creek, Saguache County			
274490 ♀, adult	308	188	74.5	72.7	71.0	126.5
			Archuleta County			
149116 ♂, young adult	333	214	82.5	73.2	78.1	134.5
213002 ♀, young adult	296	189	63.2	68.5	68.6	113.8

[a] Measurements of condylobasal length and zygomatic breadth were taken with metric rule graduated in halves of millimeters.

[b] See Warren (1932f:21).

Ursus planiceps Merriam, N. Amer. Fauna, 41:37, 9 February 1918; type locality, Colorado, "probably in the foothills or on the western edge of the plains."

Ursus macrodon Merriam, N. Amer. Fauna, 41:38, 9 February 1918; type locality, Twin Lakes, Lake Co., Colorado.

Warren (1932f) pointed out that this plethora of names most probably is biologically meaningless. Later, Warren (1942:43) gave approximate home ranges of certain well-known individual grizzlies. "Old Clubfoot" was estimated to have a range some 45 miles square, from the head of Muddy Creek southward perhaps to Black Mesa. Hall and Kelson (1959:869) noted that "since the home range of an individual grizzly bear has been known to cover an area 45 miles in diameter in Colorado . . . and since 3 full species have been described within a distance of 100 miles in that state, it seems possible that some of the names have been applied to family groups of bears."

I have examined holotypes of two of the above named kinds and have compared observed characters with original descriptions. Descriptions of individual holotypes are detailed and accurate. To a lesser degree, descriptions apply to specimens later referred to the nominal taxa (see, for example, Merriam, 1929). I seriously doubt, however, that the names proposed for Coloradan grizzly bears convey any biological information about the species involved. The size of the skull of a grizzly is such that minor individual variations in conformation are readily observed and described. From most parts of the range, only single specimens are available from widely scattered areas. There is no possible way to gain any real appreciation for the degree and mode of variation within the deme. However, to imagine that observed variation within Coloradan grizzlies represents differences between biological species or even recognizable geographic races seems to me incredible.

Of the four nominal species named from Colorado, only two have well-fixed type localities. For discussion of type localities of *Ursus planiceps* and *Ursus bairdi,* see Warren (1932f).

I follow Rausch (1963 and elsewhere) in the use of the name *Ursus arctos* for the North American grizzly bear.

Records of occurrence.—Specimens examined, 21, distributed as follows: LARIMER COUNTY: Estes Park, 1 (USNM). RIO BLANCO COUNTY: White River, 1 (USNM). GARFIELD COUNTY: Trappers Lake, 1 (KU). EAGLE COUNTY: Dotsero, 2 (KU). GRAND COUNTY: Kremmling, 1 (USNM); S branch Williams Fork, 2 (USNM). SUMMIT COUNTY: Blue River, 1 (USNM). GUNNISON COUNTY: California Park, Cochetopa [Gunnison] National Forest, 1 (USNM). SAGUACHE COUNTY: 12 mi. NE Saguache, 1 (USNM); Upper Saguache Creek, 1 (USNM). SAN MIGUEL COUNTY: Lone Cone, 11,000 ft., 1 (USNM). MINERAL COUNTY: Middle Fork [Middle Creek?], S of Creede, 1 (USNM); Lake Fork [Lake Creek?], 20 mi. S Wagon Wheel Gap, 1 (USNM). ARCHULETA COUNTY: Pagosa Springs, 2 (USNM); Navajo Range, near Chromo, 3 (USNM). County unknown: *Indian Creek,* 1 (USNM).

Additional records (Cary, 1911:197-199, unless otherwise noted): MOFFAT COUNTY: bend of Yampa River, between Lay and Fortification creeks (Farnham, 1839, 2:3). LARIMER COUNTY: Medicine Bow Range, near Rocky Mountain National Park (Tully, 1970). GARFIELD COUNTY: N side Book Plateau; Miller Creek, near Glenwood Springs. EAGLE COUNTY: head of Gypsum Creek. GRAND COUNTY: Mount Baker, Rabbit Ears Mountains; "region about Strawberry and Grand lakes"; Sleepy Gap, Williams River Mountains. JEFFERSON COUNTY (?): *"about 40 miles from Denver"* (Coues, 1879:221). MESA COUNTY: Grand Mesa (Tully, 1970); "Dominguez Country, 25 miles south of Grand Junction" (Warren, 1942:42). PARK COUNTY: NW corner Black Mountain (Warren, *loc. cit.*). DELTA COUNTY: 18 mi. N Delta (Warren, *loc. cit.*). EL PASO COUNTY: base of Pikes Peak (James, 1823,1:230). SAN MIGUEL COUNTY: North Mesa, across Naturita Valley from Lone Cone; Dry Creek Basin. FREMONT COUNTY: eastern part of county (James, 1823,1:239). CUSTER COUNTY: *near Ilse* (Cockerell, 1890:7). DOLORES COUNTY: West Dolores River. HINSDALE COUNTY (Tully, 1970): Rio Grande Pyramid; head of Pine [Los Piños] River. MINERAL COUNTY (Tully, 1970): Goose Creek; Red Mountain Creek; Window Lake, sec. 15, T. 38 N, R. 2 W; Coldwater Creek, Upper Piedra River. RIO GRANDE COUNTY: Burro Mountain, near Elwood. BENT COUNTY: near mouth of Purgatoire River. LA PLATA COUNTY: N of Vallecito. ARCHULETA COUNTY: N of Pagosa Springs; near Pagosa Hot Springs (Coues and Yarrow, 1875:66); Iron Creek (Tully, 1970); Chama Peak (Tully, 1970).

FAMILY MUSTELIDAE—WEASELS AND ALLIES

KEY TO SPECIES OF MUSTELIDAE IN COLORADO

1. Premolars 4/4 2
   Lower premolars 3, upper premolars 2 to 4 3

2. Body slender, tail greater than one-half length of head and body; condylobasal length less than 90 .... *Martes americana*

   Body stout, tail less than one-third length of head and body; condylobasal length greater than 130 .... *Gulo gulo*

3. Toes webbed; premolars 4/3, upper molar nearly square .. *Lutra canadensis*

   Toes not webbed; premolars fewer than 4/3, upper molar of variable shape, but not square 4

4. Color sematic, a pattern of white and black; bullae small, flattened 5

   Color not a pattern of white and black; bullae large, rounded 7

5. Dorsum black and white; premolars 3/3 6

   Dorsum solid white; premolars 2/3 .... *Conepatus mesoleucus*

6. Dorsum with two continuous white stripes; condylobasal length greater than 60 .... *Mephitis mephitis*

   Dorsum with four or more lines of irregular spots; condylobasal length less than 60 .... *Spilogale putorius*

7. Body stout, white stripe on head, foreclaws 30 or longer; condylobasal length greater than 110 .. *Taxidea taxus*

   Body slender, without white stripe on head, foreclaws less than 20; condylobasal length less than 80 8

8. Hind foot greater than 55; condylobasal length greater than 60 9

   Hind foot less than 50; condylobasal length less than 55 10

9. Color of body and tail yellowish white; tip of tail, face-mask, and feet blackish .... *Mustela nigripes*

   Color of body and tail medium to dark brown; tip of tail, face, and feet not distinctively colored .... *Mustela vison*

10. Venter white to sulphur-yellow in summer; condylobasal length less than 35 11

    Venter orangish brown in summer; condylobasal length greater than 40 .... *Mustela frenata*

11. Tail greater than one-fourth length of head and body; tip of tail solid black .... *Mustela erminea*

    Tail one-fourth or less length of head and body; tip of tail with at most a few black hairs .... **Mustela nivalis*

Martes americana

MARTEN

The marten is a boreal mammal that is distributed southward in suitable habitat in the Sierra Nevada and in the Rocky Mountains. In Colorado, martens are restricted to the mountains, typically in areas of dense forests of lodgepole pine or spruce and fir. Most records are from above 9000 feet. The mean annual reported harvest of martens in Colorado over the 10-year period 1958-1967 was only 50 (range, 33 in 1959 to 75 in 1958). Streeter and Braun (1968) presented observations on martens above timberline in Colorado, and Yeager and Remington (1956) studied the habitat of this mustelid. Indirect effect on marten of spruce-beetle damage in Coloradan forests was studied by Yeager and Riordan (1953). Hagmeier (1956) discussed the distribution of the marten in North America.

Martes americana origenes (Rhoads)

Mustela caurina origenes Rhoads, Proc. Acad. Nat. Sci. Philadelphia, 54:458, 30 September 1902; type locality, Marvine Mountain, Rio Blanco Co., Colorado (see remarks).

Martes americana origenes, Wright, Jour. Mamm., 34:84, 9 February 1953.

Distribution in Colorado.—Higher elevations in mountains of western three-fifths of state (Fig. 98).

Measurements.—External measurements of the holotype (USNM 112170, a female) are: 612, 210, 76; weight, 1 1/4 pounds. Selected cranial measurements of a male from Gunnison County, a female from western Larimer County, and the holotype, are, respectively: condylobasal length, 81.8, 72.9, 71.3; zygomatic breadth, 46.8, 42.4, 39.1; interorbital constriction, 18.8, 16.3, 15.7; mastoid breadth,

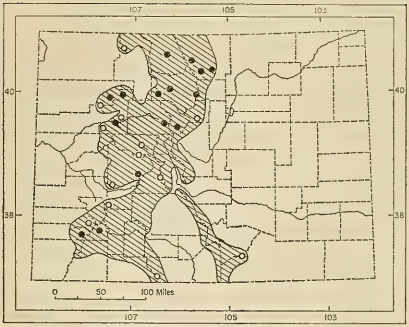


Fig. 98. Distribution of *Martes americana origenes* in Colorado. For explanation of symbols, see p. 9.

38.6, 33.9, 34.0; length of maxillary toothrow, 29.9, 29.5, 29.3.

Remarks.—The type locality of *M. a. origenes* usually is cited as Marvine Mountain, Garfield Co., Colorado. Ernest Thompson Seton, who collected the holotype, cited the type locality as "Marvine Lodge, Garfield Co., Colo." (1929, 2:484). Marvine Lodge and most of Marvine Mountain are in extreme eastern Rio Blanco County.

Hagmeier (1956:153) remarked that the marten in Colorado occurred ". . . as far east as western Arapahoe County. . . ." At that latitude, the easternmost county of occurrence probably is Jefferson. Yeager (1950) was cited as authority for the Arapahoe County record; I find no reference in the latter paper to Arapahoe County.

Hagmeier (1961) studied geographic variation in *M. americana,* concluding that the use of subspecific nomenclature in the "*caurina* group" of nominal races did not describe observed variation adequately. Long (1965: 689) reviewed Hagmeier's work and concluded that two subspecies could be recognized in Wyoming. In view of that usage in Wyoming, the name *origenes* is maintained herein for Coloradan martens.

Records of occurrence.—Specimens examined, 31, distributed as follows: ROUTT COUNTY: *no locality other than county,* 2 (DMNH). JACKSON COUNTY: North Park, 1 (AMNH). LARIMER COUNTY: Peterson Lake, SW 1/4 sec. 22, T. 7 N, R. 75 W, 1 (CSU); [near] Arkins, 1 (USNM); Rainbow Curve, Trail Ridge Road, 1 (RMNP). RIO BLANCO COUNTY: Marvine Mountain, 1 (USNM). GARFIELD COUNTY: Trappers Lake, 1 (CSU); Glenwood Springs, 1 (DMNH). EAGLE COUNTY: W of Vail Pass, 1 (DMNH). GRAND COUNTY: Middle Park, 1 (DMNH); Sheephorn Mountains, 6 mi. SW Kremmling, 1 (USNM). SUMMIT COUNTY: Breckenridge, 1 (DMNH). BOULDER COUNTY: *Camp Albion, 10,000 ft.,* 1 (FMNH); *Silver Lake, 10,000 ft.,* 2 (FMNH); timberline, Arapahoe Peak, 11,000 ft., 1 (FMNH); *8 mi. W Nederland,* 1 (USNM). GUNNISON COUNTY: *4 mi. upstream from mouth of Spring Creek,* 3 (WSC); *Spring Creek,* 4 (WSC); 3 mi. N Almont, 8300 ft., 1 (KU). DOLORES COUNTY: Rico, 1 (FWS). SAN JUAN COUNTY: Silverton, 1 (USNM); *Sultan Mountain,* 3 (USNM).

Additional records (Cary, 1911:189-190, unless otherwise noted): ROUTT COUNTY: Elkhead Mountains. JACKSON COUNTY: near Rabbit Ears Pass (Remington, 1952:66). GARFIELD COUNTY: Mud Springs, White River Plateau; Bennett Spring, Noname Creek, 8 mi. NE Glenwood Springs; Divide Creek, S of New Castle; White River National Forest (T. R. Williams, 1957:517). GRAND COUNTY: 3 mi. SW Rabbit Ears Pass (Vaughan, 1969:53). CLEAR CREEK COUNTY: summit of Mount Evans (Streeter and Braun, 1968:62). PITKIN COUNTY: S of Aspen; near Montezuma Mine, Hayden Peak. PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:37). GUNNISON COUNTY: Tin Cup Mine, Union Park; Black Mesa (Halvorsen, 1961:111); headwaters of Cimarron Creek. SAN MIGUEL COUNTY: Telluride. ARCHULETA COUNTY: 45 mi. W Antonito (card file, U.S. Fish and Wildlife Service). LAS ANIMAS COUNTY: East Spanish Peak.

Mustela erminea

Ermine

The ermine, or short-tailed weasel, is the smallest of Coloradan mustelids and generally is a mammal of wooded regions, but is known in the state from localities both above and below the zones of forest. The species appears to be nowhere common in Colorado, although Hayward (1949) thought it as abundant as *Mustela frenata* at Gothic. On the other hand, Quick (1951) reported never having seen *Mustela erminea* during the course of his studies on the long-tailed weasel in Gunnison County. Extremes of elevation of specimens examined are about 5300 feet near Denver and near Argentine Pass at 13,000 feet. A specimen from Boulder (CU 3140) bears the notation "caught in house [on] February 8, 1929. . . ." The specimen from Denver

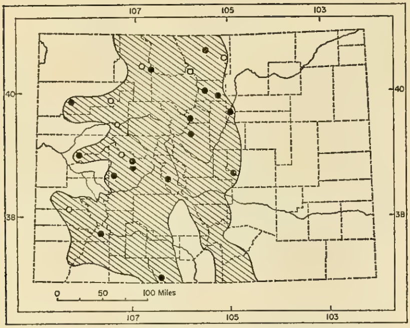


FIG. 99. Distribution of *Mustela erminea muricus* in Colorado. For explanation of symbols, see p. 9.

(DMNH 2510) was reported by Seton (1933) as *Mustela rixosa [=M. nivalis].* F. W. Miller (1933b) corrected that misidentification.

Little has been recorded concerning the natural history of the ermine in Colorado. Data on the species elsewhere in its wide range in North America were reviewed by Hall (1951b). The diet consists mostly of small rodents and insectivores; Dixon (1931) observed an ermine trying to capture a pika near Milner Pass, Rocky Mountain National Park.

Mustela erminea muricus (Bangs)

Putorius (Arctogale) muricus Bangs, Proc. New England Zool. Club, 1:71, 31 July 1899; type locality, Echo, 7500 ft., El Dorado Co., California.

Mustela erminea murica, Hall, Jour. Mamm., 26: 181, 27 February 1945.

Putorius streatori leptus Merriam, Proc. Biol. Soc. Washington, 16:76, 29 May 1903; type locality, Silverton, San Juan Co., Colorado (regarded as inseparable from *M. e. muricus* by Hall, 1945:181).

Distribution in Colorado.—Forests of mountainous parts of state, and occasionally above timberline or in foothills (Fig. 99).

Measurements.—External measurements of males from Montrose and San Juan counties and a female from Gunnison County are: 227, 243, 206; 60, 64, 51; 30, 31, 25; —, —, 14. Three females weighed 44, 40, 30. Selected cranial measurements of the same two males and female, and of a female from Larimer County, are, respectively: condylobasal length, 33.6, 33.9, 31.5, 32.1; zygomatic breadth, 17.0, 17.6, 16.2, 16.4; interorbital constriction, 7.0, 7.4, 6.7, 6.5; length of maxillary toothrow, 9.3, 9.0, 8.8, 8.9.

Remarks.—Specimens available from Colorado represent widely scattered localities, but generally are homogeneous in appearance both externally and cranially. An exceptional specimen (KU 116876) from near Gothic, Gunnison County, shows a heavy sulfur-yellow wash over the venter forward to the chin and cheeks, which are white; a faint yellow to drab wash also is present on the subterminal bands of hairs of the sides and flanks.

Records of occurrence.—Specimens examined, 20, distributed as follows: JACKSON COUNTY: Rabbit Ears Pass, 9680 ft., 1 (CSU). LARIMER COUNTY: Ben Delatour Boy Scout Ranch [about sec. 18, T 9 N, R. 72 W], 2 (CSU). RIO BLANCO COUNTY: Little Hills Experiment Station, 6000 ft., 1 (CSU). BOULDER COUNTY: Niwot Ridge, 1 (CU); *Camp Albion, 10,600 ft.,* 1 (FMNH); Boulder, 2 (1 CU, 1 USNM). CLEAR CREEK COUNTY: McClellan Ridge, near Argentine Pass, 13,000 ft., 1 (CU). DENVER COUNTY: Denver, 1 (DMNH). MESA COUNTY: Land's End Road, Grand Mesa, 1 (CSU). PARK COUNTY: Jefferson, 1 (DMNH). GUNNISON COUNTY: 1/2 mi. S Rocky Mountain Biological Laboratory, near Gothic, 1 (KU); Crested Butte, 9000 ft., 2 (1 USNM, 1 WC); Black Mesa, 10 mi. E Crawford, 1 (CSU). CHAFFEE COUNTY: Arbourville, 1 (USNM). EL PASO COUNTY: Turkey Creek, 6800 ft., SW of Colorado Springs, 1 (WC). SAN JUAN COUNTY: Silverton, 1 (USNM). CONEJOS COUNTY: Trujillo Meadows, 1 mi. S, 24 mi. W Antonito, about 10,200 ft., 1 (UNM).

Additional records (Cary, 1911:187, unless otherwise noted): ROUTT COUNTY: Steamboat Springs. LARIMER COUNTY: [near] Fort Collins (card file, U.S. Fish and Wildlife Service, submitted by W. L. Burnett); Milner Pass, Rocky Mountain National Park (Dixon, 1931:72). RIO BLANCO COUNTY: Marvine (Hall, 1951b:164). GARFIELD COUNTY: Glenwood Springs. GRAND COUNTY: *3 mi. SW Rabbit Ears Pass, 9900 ft.* (Vaughan, 1969:53). BOULDER COUNTY: *5 mi. W Boulder; near Boulder* (Coues, 1879:220). PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:37). GUNNISON COUNTY: near Placita (Hall, 1951b:164); *Rocky Mountain Biological Laboratory, Gothic* (Hayward, 1949:437). CHAFFEE COUNTY: *Hancock* (Hall, 1951b:164). MONTROSE COUNTY: Coventry (Warren, 1942:62).

Mustela frenata

LONG-TAILED WEASEL

Mustela frenata has the broadest ecological and geographic range of any Coloradan mustelid. The species occurs from southern Can-

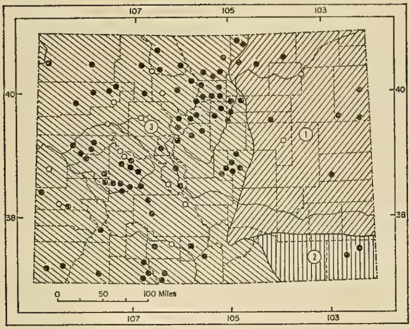


FIG. 100. Distribution of *Mustela frenata* in Colorado. 1. *M. f. longicauda.* 2. *M. f. neomexicana.* 3. *M. f. nevadensis.* For explanation of symbols, see p. 9.

ada southward to northern Bolivia. In Colorado, long-tailed weasels occur statewide, from lowest elevations to well above timberline in the mountains. They are to be found in forested areas, open woodlands, on the open plains, or in alpine situations.

Quick (1951) discussed food habits of *M. frenata* in Gunnison County. Feeding behavior was described by F. W. Miller (1931b), Warren (1932a) presented notes on breeding of long-tailed weasels in the state, and F. W. Miller (1930c, 1931a) described molt in captives. The monograph of American weasels by Hall (1951b) contains a review of literature on natural history of *M. frenata* to that time, as well as a thorough taxonomic treatment of recognized subspecies.

Mustela frenata longicauda Bonaparte

Mustela longicauda Bonaparte, Charlesworth's Mag. Nat. Hist., 2:38, January 1838; type locality uncertain, possibly Carlton House [Carlton], Saskatchewan (see Hall, 1951b:120-123).

Mustela frenata longicauda, Hall, Carnegie Inst. Washington Publ., 473:105, 20 November 1936.

Distribution in Colorado.—Plains of eastern one-third of state (Fig. 100).

Comparisons.—From *M. f. nevadensis,* the subspecies of the mountains and immediately adjacent plains, *M. f. longicauda* differs in markedly paler dorsal color and generally paler ventral color (in summer pelage), and in larger size both externally and cranially. For comparison with *M. f. neomexicana,* see account of that subspecies.

Measurements.—External and cranial measurements of a male (CSU 10052) from southern Weld County are: 406, 149, 50, 23, weight, 267; condylobasal length, 49.8; zygomatic breadth, 28.7; interorbital constriction, 11.3; postorbital constriction, 9.4; mastoid breadth, 25.9; length of maxillary toothrow, 15.6.

Records of occurrence.—Specimens examined, 8, distributed as follows: WELD COUNTY: 2 mi. E New Raymer, 1 (CU); 2 mi. S, 1 mi. E Galeton, 1 (UNM); 3 mi. NE Windsor, 1 (CSU). ARAPAHOE COUNTY: Deer Trail, 1 (DMNH). YUMA COUNTY: Wray, 1 (DMNH); 3 mi. N, 7 mi. E Kirk, 1 (KU); Bonny Reservoir, 1 (CSU). CHEYENNE COUNTY: 3 mi. S, 4 mi. W Kit Carson, 1 (FHSC).

Additional records: WASHINGTON COUNTY: 4 mi. NE Hillrose (Hall, 1951b:289, as *nevadensis*). ELBERT COUNTY: 4 mi. W River Bend (sight record, DMA field notes, 9 July 1969).

Mustela frenata neomexicana
(Barber and Cockerell)

Putorius frenatus neomexicanus Barber and Cockerell, Proc. Acad. Nat. Sci. Philadelphia, 50:188, 3 May 1898; type locality, Armstrong's Lake, Mesilla, 8300 ft., Dona Ana Co., New Mexico.

Mustela frenata neomexicana, G. S. Miller, Jr., Bull. U.S. Nat. Mus., 79:100, 31 December 1912.

Distribution in Colorado.—Known certainly only in Baca County, but probably more widespread in southeastern part of state (Fig. 100).

Comparisons.—*Mustela f. neomexicana* differs from other Coloradan long-tailed weasels in the presence of prominent white facial markings and in larger external and cranial size.

Measurements.—External and cranial measurements of a young adult female from near Two Buttes (CSU 8718) are: 392, 135, 38, 21; condylobasal length, 46.9; zygomatic breadth, 25.2; interorbital constriction, 10.0; postorbital constriction, 9.5; mastoid breadth, 10.0; length of maxillary toothrow, 13.1.

Records of occurrence.—Specimens examined, 2, distributed as follows: BACA COUNTY: 2 1/2 mi. S Two Buttes, 1 (CSU); near Springfield, 1 (DMNH).

Mustela frenata nevadensis Hall

Mustela frenata nevadensis Hall, Carnegie Inst. Washington Publ., 473:91, 20 November 1936; type locality, 3 mi. E Baker, White Pine Co., Nevada.

Distribution in Colorado.—Mountains and adjacent plains of western two-thirds of state (Fig. 100).

Comparisons.—For comparison with other Coloradan subspecies, see accounts of those taxa.

Measurements.—Mean (and extreme) external measurements of four males, followed by those of 11 females, all from Grand and Black mesas, Delta and Gunnison counties, are: 427.5 (410-441), 351.3 (318-378); 148.5 (139-160), 126.5 (111-155); 44.0 (41-49), —; 21.5 (16-26), —; mean weight of nine females, 148.23 (113-196).

Cranial measurements of three males, followed by the mean (and extremes) of 11 females, all from Delta and Gunnison counties, include: condylobasal length, 51.2, 48.5, 48.1, 42.66 (41.0-43.9); zygomatic breadth, 29.9, 27.4, —, 23.05 (22.5-23.6); interorbital constriction, 12.0, 11.0, 9.9, 9.21 (8.8-10.0); postorbital constriction, 10.0, 10.0, 8.0, 9.40 (7.6-10.0); mastoid breadth, 25.9, 23.6, 24.1, 20.61 (19.6-21.9); length of maxillary toothrow, 15.7, 14.8, 14.3, 12.85 (11.7-13.6). Selected cranial measurements of three males from the vicinity of Fort Collins are: condylobasal length, 51.9, 50.3, 48.3; zygomatic breadth, 27.2, 27.8, 27.7; interorbital constriction, 11.4, 11.3, 10.8; postorbital constriction, 8.0, —, 9.3; mastoid breadth, 25.3, 25.7, 23.8; length of maxillary toothrow, 15.9, 15.2, 15.1.

Remarks.—Hall (1951b:284) discussed the large size of long-tailed weasels from northwestern Colorado and adjacent areas.

Specimens from eastern Larimer County and northwestern Weld County are larger than is usual for *nevadensis,* therein approaching *longicauda.* A similar situation obtains farther south on the plains along the Front Range, and I follow Hall (1951b) in referring apparent intergrades to *nevadensis* on the basis of color.

Records of occurrence.—Specimens examined, 164, distributed as follows: MOFFAT COUNTY: Castle Park, Dinosaur National Monument, 1 (CU); Lay, 6150 ft., 1 (WC). ROUTT COUNTY: *Elk Mountain Meadow,* 1 (DMNH); Steamboat Springs, 2 (1 USNM, 1 WC); *3 mi. S, 3 mi. W Steamboat Springs, 7000 ft.,* 1 (CSU); 3 mi. E Toponas, 1 (CSU). JACKSON COUNTY: Higho, 8000 ft., 1 (USNM); 3 mi. N, 2 mi. E Gould, 1 (KU); Arapahoe Creek, 1 (CSU). LARIMER COUNTY: Fort Collins, 2 (CSU); *Spring Canyon,* 1 (CSU); *Drake's Beet Dump, 5000 ft.,* 1 (CSU); *4 1/2 mi. S, 1 1/2 mi. E Fort Collins,* 1 (CSU); Loveland, 4 (DMNH); *Trail Ridge Road by banner trees,* 1 (RMNP); Estes Park, 7500 ft., 2 (1 AMNH, 1 CSU); *Trail Ridge Road by Longs Peak Sign,* 1 (RMNP); *Beaver Meadows Entrance, Rocky Mountain National Park,* 1 (RMNP); *Colorado Highway 66, near Beaver Point,* 1 (RMNP); *Beaver Meadows,* 3 (RMNP); *2 mi. S Estes Park,* 1 (CSC); *3 1/2 mi. SE Estes Park,* 1 (KU); *above Glacier Basin Campground,* 1 (RMNP); Pinewood, 1 (USNM); *Peak-to-Peak Highway, 1/8 mi. S road to Longs Peak Ranger Station,* 1 (RMNP); *Rocky Mountain National Park,* 1 (RMNP). WELD COUNTY: 20 mi. N Nunn, 1 (FWS); *9 mi. N Nunn,* 1 (CSU); 10 2/10 mi. NE Nunn, 1 (CSU); *1 mi. N, 6 mi. E Wellington,* 1 (CSU). RIO BLANCO COUNTY: 1 mi. NW Pagoda Peak, 10,400 ft., 1 (KU); Dry Fork, White River, 6200 ft., 2 (AMNH); *Dry Fork, White River, 6300 ft.,* 1 (AMNH); *Dry Fork, White River, 6600 ft.,* 1 (AMNH); Meeker, 1 (USNM); Piceance Creek, 6200 ft., 1 (AMNH); *Compass Creek, 9000 ft.* (not found), 1 (AMNH). GRAND COUNTY: *west side Rocky Mountain National Park,* 1 (RMNP); 2 mi. W Grand Lake, 1 (RMNP); Middle Park, 1 (DMNH). BOULDER COUNTY: foot of Mount Meeker, 1 (AMNH); 12 mi. N Boulder, 1 (FWS); *3 mi. S Ward,* 1 (KU); *Sugarloaf,* 1 (CU); Roger's Park, 10 1/2 mi. W Boulder, 1 (CU); Boulder, 3 (2 CU, 1 FMNH); Dixie Lake, 2 (1 AMNH, 1 DMNH); Caribou, 1 (AMNH); *no locality other than county,* 1 (FMNH). CLEAR CREEK COUNTY: Silverplume, 3 (2 SC, 1 WC); *Graymount,* 1 (WC); Gray's Peak, 1 (KU); *Reed Mills,* 1 (MCZ). JEFFERSON COUNTY: Semper, 1 (DMNH); *6 mi. W Denver,* 1 (DMNH); Denver Mountain Parks, 7000 ft., 1 (DMNH). ADAMS COUNTY: East Lake, 1 (DMNH); Barr, 1 (AMNH). DENVER COUNTY: Denver, 1 (AMNH). ARAPAHOE COUNTY: Littleton, 1 (WC). MESA COUNTY: 2 mi. N, 9 mi. E Collbran, 7000 ft., 1 (KU); Tunnel, 1 (USNM); 9 mi. S, 3 mi. E Collbran, 1 (KU); 13 mi. SSE Mesa, 10,000 ft., 1 (CSU); 28 mi. E Grand Junction, 1 (KU). LAKE COUNTY: 9 mi. SW Leadville, 11,000 ft., 1 (KU). PARK COUNTY: Shawnee, 1 (USNM); Jefferson, 3 (1 AMNH, 2 USNM); Mount Bross, 1 (DMNH). DELTA COUNTY: 6 mi. E Skyway, 10,500 ft., 1 (KU); Grand Mesa, 2 (CSU); *1 1/2 mi. S, 8 mi. E Skyway, 9500 ft.,* 1 (KU); *1 1/2 mi. S, 8 mi. E Skyway, 9600 ft.,* 1 (KU); 2 mi. S, 8 mi. E Skyway, 9000 ft., 1 (KU); Clear Fork of Smith's Creek, near Crawford, 1 (WC). GUNNISON COUNTY: *S face Virginia Peak,* 1 (UMMZ); Gothic, 9500 ft., 1 (USNM); *Crested Butte-Gothic Road, 9800 ft.,* 1 (WC); Lake Brennan, Irwin, 10,500 ft., 1 (WC); Crested Butte, 9000 ft., 4 (1 KU, 3 WC); *1 mi. SE Crested Butte, 9000 ft.,* 1 (KU); 19 2/10 mi. N Gunnison, 1 (WSC); Black Mesa, 7 (6 CSU, 1 UNM); *25 mi. SE Crawford, 10,000 ft.,* 1 (CSU); 10 mi. N Sapinero, 7000 ft., 1 (CSU); *1/2 mi. N XF Ranch, Black Mesa, 10,000 ft.,* 1 (CSU); *8 mi. NW Sapinero,* 1 (USNM); 10 mi. W Gunnison, 1 (CSU); 1 mi. E Gunnison, 7700 ft., 1 (KU); *1/2 mi. S Tomichi Bridge,* 1 (WSC); 2 mi. S Gunnison, 1 (WSC); Sapinero, 1 (WC). CHAFFEE COUNTY: Buena Vista, 1 (UMMZ); *4 mi. above Salida,* 1 (WC); Salida, 7050 ft., 3 (WC). TELLER COUNTY: Glen Cove, 1 (UMMZ); 1 mi. N Cripple Creek, 1 (UNM). EL PASO COUNTY: Monument, 1 (UMMZ); *Roberts Ranch, Monument Creek,* 1 (WC); Falcon Stadium, United States Air Force Academy, 1 (SCSC); *E of Colorado Springs, 6000 ft.,* 1 (WC); Sand Creek, 5 mi E Colorado Springs, 1 (WC); *Seven Lakes, 10,975 ft.,* 1 (WC); Lake Moraine, 10,250 ft., 1 (WC). MONTROSE COUNTY: Maher, 1 (WC); West Paradox Valley, 1 (DMNH); Coventry, 2 (USNM). SAGUACHE COUNTY: 20 mi. SE Gunnison, 1 (CSU); Tevebaugh's Ranch, 20 mi. W Saguache, 2 (USNM); *Houselog Creek, Cochetopa [Gunnison] National Forest* (not found), 1 (USNM); *Pierce Place, Cochetopa [Gunnison] National Forest* (not found), 1 (USNM). SAN JUAN COUNTY: 6 mi. N Silverton, 1 (WSC). RIO GRANDE COUNTY: Del Norte Peak, 1 (UMMZ); *no locality other than county,* 1 (DMNH). ALAMOSA COUNTY: no locality other than county, 1 (ASC). MONTEZUMA COUNTY: 1/2 mi. NE tunnel, Morfield Canyon, Mesa Verde National Park, 1 (KU); Ute Peak, 1 (DMNH). LA PLATA COUNTY: 2 mi. N Ignacio, 1 (UNM). ARCHULETA COUNTY: Crater Lake, 12,000 ft., 1 (UI); Upper Navajo River, 2 (DMNH); *Navajo River,* 5 (1 AMNH, 4 DMNH); Chromo, 2 (DMNH). CONEJOS COUNTY: near La Manga Pass, 1 (WC); Osier, 2 (DMNH). COSTILLA COUNTY: 1 mi. NW Blanca, 7900 ft., 1 (KU).

Additional records (Hall, 1951b:289, unless otherwise noted): JACKSON COUNTY: *near Rand.* RIO BLANCO COUNTY: *White River, 6210 ft.;* Marvine. GARFIELD COUNTY: near New Castle (Felger, 1910:133). EAGLE COUNTY: Eagle, 9500 ft. GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53); "Crembling [=Kremmling?]." BOULDER COUNTY: *Silver Lake Mine.* MESA COUNTY: 9 mi. S, 1 mi. W Glade Park P. O. (sight record, DMA field notes, 6 August 1969). PITKIN COUNTY: Placita. GUNNISON COUNTY: (Findley and Negus, 1953:236, unless otherwise noted): Marble (Hall, 1951b:289); *4/10 mi. NW Gothic; 9/10 mi. NW Gothic, 9700 ft.; Sylvanite Basin, 3 1/10 mi. NE Gothic, 11,500 ft.* CHAFFEE COUNTY: Hancock. MONTROSE COUNTY: *Paradox;* Naturita. SAGUACHE COUNTY: Villa Grove. RIO GRANDE COUNTY: between Monte Vista and Del Norte. MONTEZUMA COUNTY (Anderson, 1961:60): *"Indian Cornfield," Mesa Verde National Park; North Rim, Mesa Verde.* COSTILLA COUNTY: *Fort Garland* (Coues and Yarrow, 1875:59).

Mustela nigripes

BLACK-FOOTED FERRET

The black-footed ferret is a specialized carnivore, formerly widespread in grasslands of the plains, western valleys, and mountain parks of Colorado. The maximum known elevation of occurrence is above 10,000 feet, based on a specimen found dead in Lake Moraine, El Paso County, and reported by Warren (1906:264). *Mustela nigripes* preys in large part on prairie dogs and available records indicate that the ranges of species of *Cynomys* and that of the black-footed ferret were at one time essentially co-extensive. However, the campaign to eradicate prairie dogs in favor of intensive agriculture and grazing has led to substantial reduction in populations of these rodents over much of the state. The near extirpation of the black-footed ferret in Colorado and elsewhere throughout its range probably is a direct result of programs to control prairie dogs. The U.S. Department of Interior (1966:M-15) recognizes the black-footed ferret as "endangered and on the verge of extinction."

Most authors are in agreement that *M. nigripes* never has been common in Colorado, or anywhere over its range, although Coues (1877:149 and 1879:220) noted that the species was not at all rare on the plains near the mountain front. The status of the species throughout its range was reviewed by Cahalane (1954) and recent reports from Colorado were listed by Lechleitner (1969:194). All records known to me of sightings in Colorado over the past 20 years have been on the eastern plains or in the extreme southwestern part of the state. The most recent records from northwestern Colorado are provided by specimens in the Carnegie Museum, captured in the vicinity of Craig in 1941 and 1942. Some positive steps are now being taken to prevent the extinction of *M. nigripes.* Henderson *et al.* (1969) reviewed the status of the black-footed ferret and commented on its natural history in South Dakota.

Mustela nigripes (Audubon and Bachman)

Putorius nigripes Audubon and Bachman, The viviparous quadrupeds of North America, 2:297, 1851; type locality, "lower waters of the Platte River"; restricted by Hayden (1863:138) to Fort Laramie, Goshen Co., Wyoming.

Mustela nigripes, G. S. Miller, Jr., Bull. U.S. Nat. Mus., 79:102, 31 December 1912.

Distribution in Colorado.—Formerly nearly statewide in suitable habitat; present status and distribution uncertain (Fig. 101).

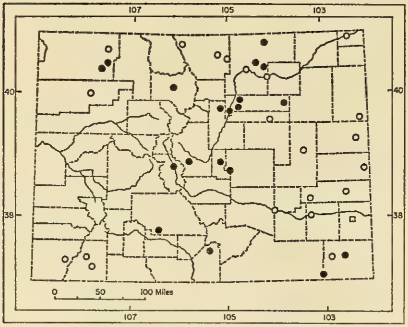


FIG. 101. Distribution of *Mustela nigripes* in Colorado. For explanation of symbols, see p. 9.

Measurements.—External measurements of males from Adams and Teller counties and of females from El Paso and Baca counties are, respectively: 496, 492, 457, 458; 113, 100, 100, 90; 59, 63, 58, 57. Cranial measurements of a male and two females from Moffat County, females from Larimer and Park counties, and the above-mentioned four individuals include: condylobasal length, 65.9, 62.9, 65.1, 67.1, 66.7, 65.0, 65.5, 60.1, 63.0; zygomatic breadth, 41.5, 37.7, 38.7, 39.8, 40.0, 41.8, —, 36.3, 37.7; interorbital constriction, 16.6, 15.8, 16.8, 16.6, 16.7, 16.5, 15.3, 15.3; postorbital constriction, 11.5, 13.1, 11.7, 12.5, 13.5, 12.1, 11.5, 14.4, 10.2; mastoid breadth, 36.2, 33.4, 35.4, 35.4, 37.0, 36.7, 34.9, 32.5, 33.0; length of maxillary toothrow, 20.2, 18.9, 19.6, 20.3, 20.6, 19.3, 20.6, 18.8, 19.6.

Records of occurrence.—Specimens examined, 30, distributed as follows: MOFFAT COUNTY: *5 mi. W Craig,* 1 (CM); Craig, 1 (CM); Morapos Creek, 1 (CM). LARIMER COUNTY: *no locality other than county,* 3 (1 ANSP, 1 CU, 1 MCZ). WELD COUNTY: 5 mi. S Grover, 2 (DMNH); 8 mi. E Cornish, 1 (WC); Greasewood, 1 (DMNH). GRAND COUNTY: Middle Park, 1 (DMNH). JEFFERSON COUNTY: Semper, 1 (DMNH). ADAMS COUNTY: Barr, 1 (DMNH); Simpson, 4 (1 AMNH, 3 DMNH); 10 mi. E Denver, 1 (DMNH). DENVER COUNTY: Denver, 2 (DMNH). PARK COUNTY: 7 mi. S Hartsel, 1 (USNM). CHAFFEE COUNTY: Buena Vista, 1 (DMNH). TELLER COUNTY: Divide Station, 9200 ft., 1 (WC). EL PASO COUNTY: Lake Moraine, 10,250 ft., 1 (WC); *no locality other than county,* 1 (AMNH). SAGUACHE COUNTY: 15 mi. NW Del Norte, 1 (USNM). COSTILLA COUNTY: Buck mountain, [NW of] Fort Garland, 1 (AMNH). BACA COUNTY: N of Springfield, 1 (WC); Furnace [Furnish] Canyon, 2 (DMNH).

Additional records (Lechleitner, 1969:194, unless otherwise noted): MOFFAT COUNTY: 22 mi. N Craig (Hall and Kelson, 1959:915). LARIMER COUNTY: Laramie River, 12 mi. S Wyoming boundary (Warren, 1910b:194); valley of Cache la Poudre River (Coues, 1877:149); NE of Timnath. WELD COUNTY: vicinity of Greeley (Coues, *loc. cit.*); 5 mi. E Dearfield (Cahalane, 1954:419). SEDGWICK COUNTY: Julesburg (card file, U. S. Fish and Wildlife Service, entry by V. Bailey). RIO BLANCO COUNTY: within 1 mi. of Meeker (Felger, 1910:146). JEFFERSON COUNTY: *near Denver* (Cahalane, 1954:419). DENVER COUNTY: *vicinity of Denver* (Coues, 1877:151). ARAPAHOE COUNTY: Deer Trail. YUMA COUNTY: Bonny Reservoir, E of Hale. PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:37). LINCOLN COUNTY: Hugo (Cary, 1911:184). KIT CARSON COUNTY: SE of Burlington. TELLER COUNTY: *Clyde* (Warren, 1942:63). EL PASO COUNTY: *near Colorado Springs* (Warren, *loc. cit.*). CHEYENNE COUNTY: U. S. Highway 40 between Weskan, Kansas, and Arapahoe, Colorado. KIOWA COUNTY: (Cary, 1911:184): Chivington; Arlington. OTERO COUNTY: Olney [Springs] (Cary, *loc. cit.*). BENT COUNTY: near Las Animas (Cahalane, 1954:419). PROWERS COUNTY: no precise locality (Cary, 1911:184). MONTEZUMA COUNTY: near Mancos (Cahalane, 1954:419). LA PLATA COUNTY: Mitchell Lakes, N of Hermosa; Lemon Dam Project, Florida River. BACA COUNTY: SE of Pritchett.

Mustela vison

MINK

The mink is not abundant today in Colorado, but the species is virtually statewide in distribution, occurring most frequently in the mountains of the central part of the state about beaver ponds at elevations to above 10,000 feet. On the plains, populations are localized, but distribution is more general in mountainous areas. According to Remington (1955), the three areas of greatest abundance of mink are the middle and upper reaches of the Yampa River, North Park, and the upper Eagle River. Early accounts (J. A. Allen, 1874:54; Coues, 1879:230) reported mink as common on the Eastern Slope, and Felger (1910:146) thought them abundant about Marvine Lodge on the White River Plateau.

Mean annual reported harvest of wild mink in Colorado over the ten-year period 1958-1967 was only 55 animals (range, 22 in 1961 to 105 in 1967).

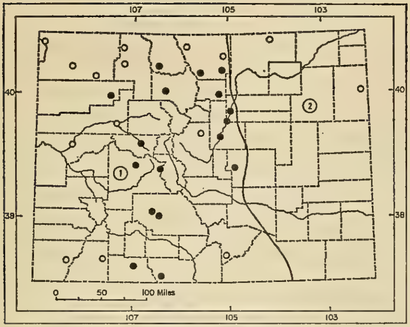


FIG. 102. Distribution of *Mustela vison* in Colorado. 1. *M. v. energumenos.* 2. *M. v. letifera.* For explanation of symbols, see p. 9.

Mustela vison energumenos (Bangs)

Putorius vison energumenos, Bangs, Proc. Boston Soc. Nat. Hist., 27:5, March 1896; type locality, Sumas, British Columbia.

Mustela vison energumenos, G. S. Miller, Jr., Bull. U. S. Nat. Mus., 79:101, 31 December 1912.

Distribution in Colorado.—Western three-fifths of state in suitable habitat (Fig. 102).

Comparison.—From *M. v. letifera*, a subspecies of the Great Plains, *M. v. energumenos* differs in smaller average cranial and external size, less robust skull, and darker color.

Measurements.—External measurements of a male from eastern Rio Blanco County are: 548, 171, 58. Cranial measurements of that individual, of two males from near Crested Butte, Gunnison County, two males from near Colorado Springs, and two males from Cochetopa Pass, include: condylobasal length, 66.5, 68.5, 63.6, 63.2, 66.9, 67.5, 68.3; zygomatic breadth, 38.5, 40.0, 35.2, 36.5, 39.9, 40.8, 40.3; postorbital constriction, 13.9, 11.8, 13.1, 11.6, 11.8, 12.5, 11.1; mastoid breadth, 34.5, 33.1, 30.0, 31.5, 34.1, 34.4, 33.6; length of maxillary toothrow, 20.6, 20.2, 19.6, 19.7, 21.2, 20.8, 20.5. Mean (and extreme) cranial measurements of 10 males, followed by those of four females, all from southeastern Larimer County, include: condylobasal length, 64.89 (61.6-69.5), 58.98 (56.9-60.5); zygomatic breadth, 37.91 (36.6-39.7); 33.68 (32.9-34.5); postorbital constriction, 11.94 (11.0-13.3), 11.40 (10.7-12.5); mastoid breadth, 32.56 (31.0-34.1), 28.72 (27.6-29.9); length of maxillary toothrow, 20.28 (19.0-21.2), 18.65 (17.4-19.3).

Records of occurrence.—Specimens examined, 48, distributed as follows: JACKSON COUNTY: Spicer, 6 (USNM). LARIMER COUNTY: *Arkins*, 13 (USNM); Loveland, 3 (1 CSU, 2 USNM); 2 mi. above Bear Lake, 1 (RMNP). RIO BLANCO COUNTY: Marvine Lodge, 1 (CU); *Flat Top Mountains*, 1 (AMNH). GRAND COUNTY: Middle Park, 1 (CU). BOULDER COUNTY: *5 mi. W Boulder, 5600 ft.*, 1 (USNM); Boulder, 1 (USNM). JEFFERSON COUNTY: Platte Cañon, 35 mi. upstream from Denver, 2 (USNM). DENVER COUNTY: Clear Creek, Denver, 1 (DMNH); *Denver*, 1 (DMNH). ARAPAHOE COUNTY: Platte River, Littleton, 1 (CU). PITKIN COUNTY: Aspen, 1 (CU). GUNNISON COUNTY: Decker's Ranch, near Crested Butte, 3 (WC). CHAFFEE COUNTY: Cottonwood Pass, 1 (UMMZ). EL PASO COUNTY: near Colorado Springs, 2 (WC). SAGUACHE COUNTY: Cochetopa Pass, 4 (USNM); Tevebaugh's Ranch, 20 mi. W Saguache, 1 (USNM). ARCHULETA COUNTY: Pagosa Springs, 1 (USNM). CONEJOS COUNTY: Conejos River, near South Fork, 2 (USNM).

Additional records (Cary, 1911:183, unless otherwise noted): MOFFAT COUNTY: Green River, near Ladore; Lily; Good Spring Creek, near Axial; *[Little] Snake River, Honnold* (not found). ROUTT COUNTY: Elkhead Mountains; Bear [Yampa] River, Hayden. LARIMER COUNTY: McIntyre Creek; Fort Collins (Warren, 1906:263). GARFIELD COUNTY: Glenwood Springs. GRAND COUNTY: *Hot Sulphur Springs; Kremmling.* MESA COUNTY: Plateau Creek, near Tunnel. PARK COUNTY: 2 mi. N, 7 mi. W Bailey, 8000 ft. (KU catalog, specimen not found); *upper South Platte River* (Blake and Blake, 1969:37). HUERFANO COUNTY: Cucharas River at La Veta. MONTEZUMA COUNTY: Mancos and Weber canyons, Mesa Verde National Park (sight records, Anderson, 1961:60). LA PLATA COUNTY: upper Los Piños River. ARCHULETA COUNTY: *San Juan River at Pagosa Springs.*

Mustela vison letifera Hollister

Mustela vison letifera Hollister, Proc. U. S. Nat. Mus., 44:475, 18 April 1913; type locality, Elk River, Sherburne Co., Minnesota.

Distribution in Colorado.—Locally along major streams of eastern part of state (Fig. 102—also see remarks).

Comparison.—For comparison with *M. v. energumenos*, see account of that subspecies.

Measurements.—I have not examined specimens of this subspecies from Colorado. Mean (and extreme) external measurements of seven males and measurements of two females from Nebraska are: 630.7 (594-686), 599, 560; 200.3 (185-217), 203, 185; 71.0 (68-76), 64, 62; 26.3 (25-27), —, — (Jones, 1964: 280). Selected cranial measurements (*op. cit.*:281) of two males and two females from Cherry County, Nebraska, are: condylobasal length, 70.3, 71.7, 63.4, 63.2; zygomatic breadth, 40.5, 39.2, 33.8, 36.0; postorbital constriction, 12.0, 14.5, 13.6, 13.2; mastoid breadth, 37.1, 36.5, 30.0, 31.7; length of maxillary toothrow, 22.7, 20.9, 20.2, 19.1

Remarks.—I have not examined specimens of *M. vison* from the plains of eastern Colorado; apparently the species has never been as abundant there as in the mountains of central and western parts of the state (see Cary, 1911:183). Nonetheless, mink do occur in eastern Colorado at some localities; for example, Mr. Gerry Siever, an employee of the state fish-rearing unit at Wray, indicated to me that mink are an important menace to fry and fingerlings there (personal communication, 6 June 1968). Jones (1964:282) reported specimens from the Republican River drainage in Dundy County, Nebraska, but had no specimens from the Platte River west of Lincoln County. Stains and Packard (1955) documented the occurrence of mink in western Kansas.

Records of occurrence.—Specimens examined, none.

Additional records: WELD COUNTY: 3 mi. N Pawnee Buttes (Hall and Kelson, 1959:918). YUMA COUNTY: near Wray (see remarks above).

Gulo gulo

Wolverine

Wolverines are boreal mammals, generally distributed in northern parts of the Holarctic Region, and occur southward along major mountain ranges. Today, the wolverine is rare in Colorado, or possibly extirpated from the state. Its numbers in the state apparently never have been great, although prior to about 1890 the species was generally distributed in densely forested parts of the higher mountains. Early accounts were compiled by Cary (1911:191-192) and by Warren (1942: 66-71). More recent sight-records by personnel of the Department of Game, Fish and Parks were discussed in publications of that agency (Spahn, 1954; Anonymous, 1946).

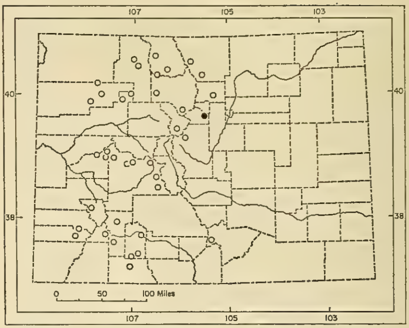


FIG. 103. Distribution of *Gulo gulo luscus* in Colorado. For explanation of symbols, see p. 9.

Historical accounts of Coloradan wolverines are not always consistent. According to Wright *et al.* (1933): "In Rocky Mountain National Park [wolverines] were present in moderate numbers during the pioneer days of that region, but none has been seen in or near the park for many years. . . ." On the other hand, Warren (1942:70) wrote: "In 1878 A. E. Sprague saw a Wolverene on the Moraine south of Moraine Park . . . . This is the only wolverene Mr. Sprague ever saw or heard of in Estes Park."

Gulo gulo luscus (Linnaeus)

[Ursus] luscus Linnaeus, Systema Naturae, ed. 10, 1:47; type locality, Hudson Bay.

Gulo gulo luscus, Rausch, Arctic, 6:114, July 1953 (also see Degerbøl, *in* Degerbøl and Freuchen, Report of Fifth Thule Expedition, 2(4):35, 1935).

Distribution in Colorado.—Early records scattered throughout higher mountains of state; present status uncertain (Fig. 103).

Measurements.—The single wolverine examined from Colorado consists of a skin without measurements or accompanying skull. Seton (1929, 2:406) noted average external measurements of four males and of seven females as follows: 1051, 940.7; 212.5, 183.5; 198.5, 177.5. The provenance of the specimens was not given, but the data were credited to R. M. Anderson, so probably the measurements are of Canadian animals. Cranial measurements of three males from northern Alaska include: condylobasal length, 144, 148, 143; zygomatic breadth, 109, 106, 103; interorbital constriction, 43, 42, 41; length of maxillary toothrow, 54.7, 42.9, 54.2 (Bee and Hall, 1956:212). For additional cranial measurements, see Rausch (1953:115).

Remarks.—The North American wolverine is treated as conspecific with the Eurasian species, *G. gulo,* after Kurtén and Rausch (1959:19) and other authors. The interested reader is directed to that paper for a summary of literature pertinent to the question of the taxonomic status of North American wolverines.

I have seen only one specimen of wolverine from Colorado. That specimen (DMNH 2723) bears the following notation: "This wolverene rec'ed from N. C. Bradbury Collection. Bradbury rec'ed it from E. Carter who is said to have collected it some where on the front Range, probably in the vicinity of Idaho Springs." Whether that specimen is one of those from Summit County, ascribed to the Carter Collection and discussed by Warren (1942:67), I do not know.

Records of occurrence.—Specimens examined, 1, as follows: CLEAR CREEK COUNTY: vicinity of Idaho Springs, 1 (DMNH—see remarks).

Additional records (Warren, 1942:66-71, unless otherwise noted): ROUTT COUNTY: Elk River, between Mad and Big creeks; Soda Creek, about 1 mi. N Steamboat Springs. JACKSON COUNTY: Red Canyon, due W of Walden (Spahn, 1954:1); Owl Mountain (Cary, 1911:191); Rabbit Ears Mountains (Cary, *loc. cit.*); head of Arapahoe Creek (Cary, *loc. cit.*). LARIMER COUNTY: Chambers Lake area (Anonymous, 1946:22); moraine S of Moraine Park. RIO BLANCO COUNTY: between Meeker and Craig (G. B. Grinnell, 1926:30); White River, 6 mi. E Meeker; between Meeker and Rio Blanco (Spahn, 1954:1). GARFIELD COUNTY: Yampa River, near Flat Top Mountains, N and E of Trappers Lake (Anonymous, 1946:22); Trappers Lake (Warren, 1906:262). GRAND COUNTY: Gore Pass, between Egeria and Middle parks (Warren, *loc. cit.*); head of Williams Fork (Cary, 1911:191); *Ranch Creek* (not found—Cary, 1911:191). SUMMIT COUNTY: near Breckenridge; *Pass Creek.* BOULDER COUNTY: near Boulder (Coues, 1879: 219). CLEAR CREEK COUNTY: *no precise locality* (Trippe, 1874:224). PARK COUNTY: near Montgomery (J. A. Allen, 1874:54). DELTA COUNTY: E end Grand Mesa; West Muddy Creek (Spahn, 1954:1). GUNNISON COUNTY: Pilot Knob, between Muddy and Hubbard creeks; headwaters of Gunnison River; vicinity of Gothic; Irwin (Warren, 1906:262); vicinity of Tin Cup Mine, Union Park (Cary, 1911:191); head of Comanche Gulch, NW of Pitkin. OURAY COUNTY: about 12-15 mi. W Ridgway (Anonymous, 1946:22). SAN MIGUEL COUNTY: Silver Picket Mine, Mount Wilson (Cary, 1911:192). DOLORES COUNTY: near Calico Mountain, W of Rico (Cary, *loc. cit.*). SAN JUAN COUNTY: headwaters of Rio Grande. HINSDALE COUNTY: Lake City area; Los Piños Creek, SE of Silverton (G. B. Grinnell, 1926:30). MINERAL COUNTY: Wheel Mountain, near Wagon Wheel Gap (Cary, 1911:191); W of Wolf Creek Pass (Anonymous, 1946:22); *Antelope Park* (Cary, 1911: 191); E base Pagosa Peak (Cary, *loc. cit.*). HUERFANO COUNTY: head of Huerfano River (Cary, *loc. cit.*). ARCHULETA COUNTY: Pagosa Springs (Anonymous, 1946:22).

Taxidea taxus

BADGER

The badger occurs throughout Colorado, from the plains of the eastern part of the state to localities above timberline in the mountains. Badgers typically are found in open situations as opposed to heavily forested areas. The species occupies a wide range in central and western North America, from northern Alberta southward to central Mexico.

Badgers seldom are observed by man, but they cannot be said to be rare in Colorado. The animals are powerful burrowers and evidence of their work is ubiquitous where the species is not directly disturbed by human intervention.

The Branch of Predator and Rodent Control reported killing 255 badgers in Colorado in 1962. A small market for badger skins exists; fur dealers handled an average of 65 skins annually over the nine-year period 1960-1968 (range, 34 in 1961 to 130 in 1968).

Taxidea taxus berlandieri Baird

Taxidea berlandieri Baird, Mammals, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):205, 14 July 1858; type locality, Llano Estacado, Texas, near boundary of New Mexico.

Taxidea taxus berlandieri, J. A. Allen, Bull. Amer. Mus. Nat. Hist., 7:256, 29 June 1895.

Taxidea taxus phippsi Figgins, Proc. Colorado Mus. Nat. Hist., 2(2):1, 10 April 1918; type locality, NE of Chromo, Archuleta Co., Colorado (regarded as a synonym of *T. t. taxus* by Hall, 1936:78; regarded as a synonym of *T. t. berlandieri* by Schantz, 1950:91).

Distribution in Colorado.—Southwestern part of state at lower elevations (Fig. 104).

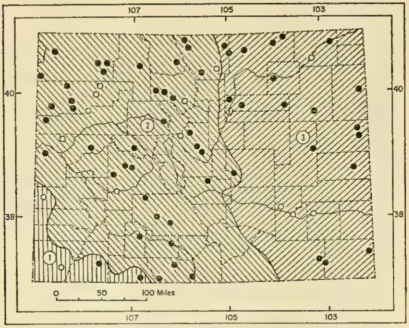


FIG. 104. Distribution of *Taxidea taxus* in Colorado. 1. *T. t. berlandieri.* 2. *T. t. montana.* 3. *T. t. taxus.* For explanation of symbols, see p. 9.

Comparisons.—From *T. t. montana,* the subspecies of central Colorado, *T. t. berlandieri* differs in smaller external and cranial size, and somewhat richer, more cinnamon to reddish color; the mid-dorsal stripe typically extends posteriorly well past the shoulders. From *T. t. taxus,* the subspecies of eastern Colorado, *T. t. berlandieri* differs in slightly smaller external and cranial size, markedly darker (more reddish brown and less grayish) pelage, and a longer mid-dorsal stripe.

Measurements.—External measurements of a male from NE of Chromo (holotype of *T. t. phippsi*) and of a female from McKinley County, New Mexico, are: 784, 710; 127, 130; 117, 100; —, 50. Selected cranial measurements of the latter specimen (KU 7582) are: condylobasal length, 119.5; zygomatic breadth, 72.4; postorbital constriction, 26.6; mastoid breadth, 71.1; length of maxillary toothrow, 38.8.

Records of occurrence.—Specimens examined, 3, distributed as follows: LA PLATA COUNTY: Pine [Los Piños] River, 1 (USNM). ARCHULETA COUNTY: [NE of] Chromo, 2 (DMNH).

Additional records: MONTROSE COUNTY: Paradox Valley (Warren, 1942:86, as *phippsi*). MONTEZUMA COUNTY: Mesa Verde National Park (sight records, Anderson, 1961:61).

Taxidea taxus montana Schantz

Taxidea taxus montana Schantz, Jour. Mamm., 31:90, 21 February 1950; type locality, 35 mi. S Dillon, Beaverhead Co., Montana.

Distribution in Colorado.—Western three-fifths of state, except extreme southwestern part (Fig. 104).

Comparisons.—From *T. t. taxus,* Coloradan specimens of *T. t. montana* differ in larger external and cranial size and in slightly more reddish color in summer pelage.

For comparison with *T. t. berlandieri,* see account of that subspecies.

Measurements.—External measurements of a male and a female from Park County are: 740, 700; 150, 140; 115, 105. Average (and extreme) cranial measurements of five males and five females from northwestern Colorado include: condylobasal length, 131.70 (129.0-137.0), 121.74 (118.3-123.8); zygomatic breadth, 87.24 (81.9-91.8), 77.10 (73.9-79.8); postorbital breadth, 30.32 (29.2-31.8), 26.78 (24.4-28.5); mastoid breadth, 82.74 (81.1-86.9), 75.24 (72.5-78.5); length of maxillary toothrow, 41.90 (39.7-44.0), 39.72 (38.6-41.0). Mean (and extreme) cranial measurements of 11 males from the San Luis Valley and the upper Rio Grande drainage include: condylobasal length, 120.23 (117.2-123.5); zygomatic breadth, 82.59 (79.5-87.8); postorbital constriction, 27.79 (26.5-29.4); mastoid breadth, 80.12 (76.7-83.6); length of maxillary toothrow, 41.56 (39.3-42.5).

Remarks.—Available skins of badgers from the mountains of Colorado are relatively homogeneous in appearance, are mostly in winter pelage, and would, for the most part, be indistinguishable from *T. t. taxus* were skulls not available. Specimens from Gunnison County and southward tend to be darker than those from localities to the north, therein approaching *T. t. berlandieri.* In the San Luis Valley, specimens tend to average smaller than animals from the northwestern part of the state. In color, the specimens resemble Coloradan representatives of *T. t. montana.* The specimens appear to be intergrades between *montana* and *berlandieri* (or perhaps *taxus,* or both), but referable to *montana.*

The taxonomy and nomenclature of geographic races of *T. taxus* is a subject of considerable confusion. In particular, the name properly applicable to the large badgers of the mountain west is a matter of debate (see Long, 1964). Dr. C. A. Long of Wisconsin State University, Stevens Point, presently is revising subspecies of *T. taxus.* That study should help to stabilize nomenclature of North American badgers, and relegate to synonymy part, at least, of the plethora of names currently in the literature. The use of the name *montana* for Coloradan badgers may well be changed in the above-mentioned revision, but geographic relationships between populations as delineated herein probably will be substantially maintained.

Records of occurrence.—Specimens examined, 67, distributed as follows: MOFFAT COUNTY: Two Bar Spring [20 mi. NW junction Little Snake and Yampa rivers], 1 (DMNH); 18 mi. W Craig, 1 (AMNH); Craig, 3 (USNM); Iles Mountain, 1 (USNM); Wagon Wheel Draw, 25 mi. NW Rangely, 2 (CM). ROUTT COUNTY: Calf Creek, Steamboat Springs, 1 (USNM). JACKSON COUNTY: Homestead Ranch, 1 (DMNH). LARIMER COUNTY: Laramie River District, Colorado [Roosevelt] National Forest, 1 (USNM); McIntyre Creek, 1 (USNM); Estes Park, 1 (WC); *Beaver Meadows Entrance, Rocky Mountain National Park,* 1 (RMNP); *junction St. Mary's Lake Road and Colorado Highway* 7, 1 (RMNP). RIO BLANCO COUNTY: White River, 20 mi. E Rangely, 1 (USNM); Piceance, 3 (USNM); 20 mi. E Dragon, Utah, 1 (CM); Little Hills Experiment Station, 31 mi. SW Meeker, 1 (CSU); *Compass Creek* (not found), 1 (AMNH). GARFIELD COUNTY: Atchee, 1 (CM); *Salt Creek,* 1 (USNM). EAGLE COUNTY: 1/2 mi. W Vail Pass, 1 (CSU). GRAND COUNTY: Gore Pass, 1 (WC); Kremmling, 1 (WC); Battle Creek, 1 (USNM). MESA COUNTY: 9 mi. S, 3 mi. E Collbran, 1 (KU); slide area, Fruita Cañon, 1 (CNM). PITKIN COUNTY: 25 mi. SE Carbondale, 1 (CSU). PARK COUNTY: Jefferson, 1 (CU); Rishabarger Gulch, near Tarryall, 1 (USNM); *Chase Gulch, near Tarryall,* 1 (USNM); Tarryall Creek, 7 mi. above Puma City, 8700 ft., 1 (WC). GUNNISON COUNTY: head of Ruby Creek Basin, near Irwin, 1 (WC); *Ruby Chief Basin Divide, Ruby Mining District,* 1 (WC); Crested Butte, 9000 ft., 2 (WC); *Cochetopa [Gunnison] National Forest,* 1 (USNM); divide between Curecanti and West Sapinero creeks, 10,000 ft., 1 (WC). EL PASO COUNTY: N of Turkey Creek, S of Colorado Springs, 1 (WC). SAGUACHE COUNTY: Stewart Peak, 25 mi. SE Gunnison, 10,000 ft., 2 (1 CSU, 1 CU); 17 mi. W Saguache, 1 (USNM); Russell Springs, 1 (USNM); *San Luis Valley,* 1 (WC). FREMONT COUNTY: 20 mi. NW Cañon City, 1 (WC). MINERAL COUNTY: "Goose Creek, Monta Vista," 1 (USNM). RIO GRANDE COUNTY: Monte Vista, 8 (USNM); *Rock Creek, [near] Monte Vista,* 1 (USNM); *Big Spring Creek, [S of] Monte Vista,* 1 (USNM); *Purdue Camp, Monte Vista* (not found), 1 (USNM). HUERFANO COUNTY: *Schuler Ranch* (not found), 1 (CU). CONEJOS COUNTY: La Jara, 2 (USNM); Rio Grande, 3 (USNM); 4 mi. W Antonito, 1 (KU).

Additional records: LARIMER COUNTY: Arkins (Schantz, 1950:92). RIO BLANCO COUNTY (Felger, 1910:145): between Axial and Meeker; Meeker; Rio Blanco stage station. GRAND COUNTY: Williams Fork Road (Gilbert and Hill, 1960: 139). MESA COUNTY (P. H. Miller, 1964:88): Book Cliffs; *Black Ridge, near W boundary, Colorado National Monument.* PARK COUNTY: Mount Lincoln (Blake and Blake, 1969:37); *South Park* (J. A. Allen, 1874:54). GUNNISON COUNTY: confluence of Red Creek and Gunnison River (Durrant and Robinson, 1962:255, as *berlandieri*); *no precise locality* (Long, 1969:146).

Taxidea taxus taxus (Schreber)

Ursus taxus Schreber, Die Säugthiere . . . , 3:520, 1778; type locality, "Labrador and Hudson Bay" (probably southwest of Hudson Bay).

Taxidea taxus, Rhoads, Amer. Nat., 28:524, June 1894.

Distribution in Colorado.—Plains of eastern two-fifths of state (Fig. 104).

Comparisons.—For comparisons with other Coloradan subspecies, see accounts of those taxa.

Measurements.—External measurements of males from Adams and Baca counties and a female from Kit Carson County are: 640, 701, 695; 108, 138, 130; 104, 102, 97; 51, —, 45; the male from Adams County weighed 13.9 pounds. Cranial measurements of males from Adams, Lincoln, and Baca counties, and of females from Kit Carson, Cheyenne, and Las Animas (two individuals) counties, respectively, include: condylobasal length, 121.4, 122.3, 120.0, 117.4, 119.2, 121.2, 123.7; zygomatic breadth, 73.0, 76.8, 79.4, 71.2, 70.8, 74.7, 77.7; postorbital breadth, 28.9, 26.7, 26.1, 27.1, 28.4, 25.7, 27.9; mastoid breadth, 69.6, 75.5, 75.3, 71.2, 70.8, 74.1, 77.4; length of maxillary toothrow, 41.7, 40.3, 41.4, 40.4, 39.3, 40.3, 38.6.

Remarks.—Two skulls from the vicinity of Estelene (near Carrizo Mountain) are larger than other badgers examined from eastern Colorado, suggesting possible intergradation with *T. t. montana.*

Records of occurrence.—Specimens examined, 21, distributed as follows: LARIMER COUNTY: 2 1/4 mi. E Wellington, 1 (CU). WELD COUNTY: N 1/2 sec. 1, T. 10 N, R. 57 W, 1 (KU); Horsetail Creek, 17 mi. NW Stoneham, 1 (DMNH); 3 mi. N, 6 mi. E Nunn, 1 (CSU); 11 mi. NE Fort Collins, 1 (CU). MORGAN COUNTY: 2 mi. N Wiggins, 1 (CU). LOGAN COUNTY: Crook, 1 (DMNH). ADAMS COUNTY: Coal Creek, 1 (DMNH); Simpson, 3 (DMNH); NW 1/4 sec. 8, T. 3 S, R. 65 W, 1 (CSU). WASHINGTON COUNTY: 2 mi. S, 4 mi. E Anton, 1 (KU). YUMA COUNTY: Dry Willow, 1 (DMNH). LINCOLN COUNTY: 20 mi. E Hugo, 1 (CSU). KIT CARSON COUNTY: Beaver Creek, 10 mi. N Burlington, 1 (KU); NE of Burlington, 1 (CSU). CHEYENNE COUNTY: Firstview, 1 (KU). LAS ANIMAS COUNTY: 25 mi. NW Estelene, 1 (USNM); 13 mi. NW Estelene, 1 (USNM). BACA COUNTY: Monon, 1 (WC).

Additional records (Cary, 1911:182, unless otherwise noted): LOGAN COUNTY: Sterling. CROWLEY COUNTY: Olney [Springs]; *no precise locality* (Rapp, 1962:217). OTERO COUNTY: Rocky Ford (Elliot, 1907:430). BENT COUNTY: Las Animas.

Spilogale putorius

Spotted Skunk

The spotted skunk occurs widely in the United States and ranges southward to Central America. In Colorado, spotted skunks represent two distinctive populations, one resident in and near the mountains, the other entering the state from the east. The status of these populations is problematic. Van Gelder (1959) revised the taxonomy of *Spilogale* and concluded that eastern and western populations are conspecific. However, Mead (1968) pointed out trenchant reproductive differences between the two.

Perhaps the eastern subspecies, *S. p. interrupta*, has come to occur in Colorado within historic times. Van Gelder (*op. cit.*:271) discussed the spread of spotted skunks northward and westward on the plains. He attributed the expansion to warmer winters and to the fact that agriculture has provided new habitats for the species. Jones (1964:288) documented the expansion of the range of the species in Nebraska. Cary (1911:180) reported that at Wray spotted skunks occurred along the sandstone bluffs.

The western subspecies, *S. p. gracilis*, is widespread in southeastern and western Colorado, where it typically inhabits rough, broken, shrub-covered terrain. Few records are from above 8000 feet. I have never seen a spotted skunk on the Eastern Slope, and the species apparently is out-numbered there by *Mephitis mephitis*, an abundant mammal in that part of the state. *Spilogale putorius* is the more abundant of the two skunks at moderate elevations on the Western Slope. Anderson (1961:60) wrote that spotted skunks were numerous in Mesa Verde National Park in some years. Cary (*op. cit.*:181) reported *Spilogale* to out-number *Mephitis* in both the southeastern and southwestern parts of the state.

The arrangement of subspecies used herein followed that of Van Gelder (1959).

Spilogale putorius gracilis Merriam

Spilogale gracilis Merriam, N. Amer. Fauna, 3:83, 11 September 1890; type locality, South Rim, Grand Canyon of the Colorado, 3500 ft., N of San Francisco Mountain, Coconino Co., Arizona.

Spilogale putorius gracilis, Van Gelder, Bull. Amer. Mus. Nat. Hist., 117:279, 15 June 1959.

Spilogale tenuis A. H. Howell, Proc. Biol. Soc. Washington, 15:241, 16 December 1902; type locality, Arkins, Larimer Co., Colorado (regarded as inseparable from *S. p. gracilis* by Van Gelder, 1959: 279).

Distribution in Colorado.—At lower to moderate elevations in broken terrain in southeastern, south-central, and western parts of state (Fig. 105).

Comparison.—From *S. p. interrupta*, the subspecies of the Great Plains, *S. p. gracilis* differs in having a white-tipped tail and broader dorsal stripes, in smaller external size, and in shorter (but relatively and actually broader) skull. For detailed comparisons, see Van Gelder (1959:282).

Measurements.—External measurements of males from Larimer and Chaffee counties are: 430, 390; 160, 135; 45, 45; 21, —. External measurements of four males and a female from the vicinity of Coventry, Montrose County, are: 420, 420, 451, 402, 380; 132, 130, 153, 127, 130; 49, 40, 41, 40, 35.

Cranial measurements of a male and mean (and extremes) of four females, all from Larimer County, include: condylobasal length, 56.2, 51.45 (50.2-53.7); zygomatic breadth, —, 32.38 (31.9-32.8); interorbital constriction, 14.7, 14.30 (13.3-16.0); postorbital constriction, 14.8, 14.30 (13.7-14.4); mastoid breadth, 30.6, 28.15 (27.2-28.4); length of maxillary toothrow, 17.5, 16.32 (16.0-16.9). Mean (and extreme) cranial measurements of six males and measurements of two females, all from the vicinity of Coventry, include: condylobasal length, 56.61 (53.8-59.6), 51.5,

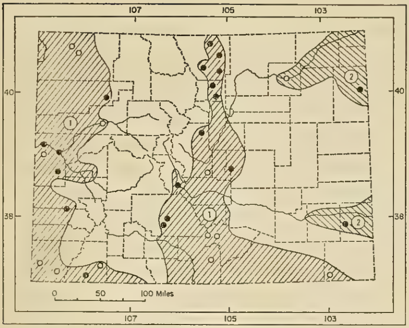


FIG. 105. Distribution of *Spilogale putorius* in Colorado. 1. *S. p. gracilis.* 2. *S. p. interrupta.* For explanation of symbols, see p. 9.

50.2; zygomatic breadth, 35.60 (34.9-38.6), 33.0, 30.5; interorbital constriction, 14.56 (14.1-15.1), 13.9, 13.5; postorbital constriction, 13.20 (12.8-13.9), —, 13.4; mastoid breadth, 31.55 (29.1-33.3), 28.3, 27.2; length of maxillary toothrow, 17.43 (16.1-18.8), 16.1, 16.3.

Remarks.—It is not known whether the ranges of *S. p. gracilis* and *S. p. interrupta* meet in Colorado, and the intergradation between the two subspecies has not been demonstrated in the state. Apparently the two kinds meet in Laramie County, Wyoming, without intergradation (see Van Gelder, 1959: 272 or Long, 1965:700). In the vicinity of Black Mesa, Cimarron Co., Oklahoma, the two subspecies apparently are adjacent but ecologically segregated, *gracilis* inhabiting the rimrock, and *interrupta* occurring along the Cimarron River (Van Gelder, *op. cit.*:284). An analogous situation is perhaps to be expected in southern Baca County, Colorado, although *S. p. gracilis* presently is the only kind of spotted skunk known from that part of the state.

A single specimen from Furnace Canyon, Baca County, was considered by Van Gelder (*loc. cit.*) to exhibit intergradation between *S. p. gracilis* and *S. p. leucoparia,* although referable to the former subspecies.

Records of occurrence.—Specimens examined, 37, distributed as follows: LARIMER COUNTY: 2 mi. NW Livermore, 2 (KU); 2 mi. N Dixon Dam, 1 (CSU); *4 mi. SW Fort Collins,* 1 (CSU); *5 mi. SW Fort Collins, 6000 ft.,* 1 (CSU); 3 mi. N Estes Park, 8000 ft., 1 (KU); *Estes Park,* 1 (AMNH); Arkins, 1 (USNM). WELD COUNTY: 2 mi. N, 4 1/2 mi. E Greeley, 2 (CSU). RIO BLANCO COUNTY: Dry Fork, White River, 6500 ft., 1 (AMNH). BOULDER COUNTY: Lyons, 1 (FMNH); *1 mi. S, 1 mi. E Lyons,* 1 (RMNP); Boulder, 1 (FMNH). MESA COUNTY: 3 mi. S Mack, 1 (CM); [2 mi. S] Grand Junction, 1 (USNM); Piñon Mesa, 30 mi. S Grand Junction, 1 (CM). PARK COUNTY: Shawnee, 1 (USNM). CHAFFEE COUNTY: Salida, 4 (1 USNM, 3 WC). EL PASO COUNTY: *Colorado Springs,* 1 (WC); Cheyenne Mountain, 1 (AMNH); *NE of Glencairn Ranch, 6000 ft.,* 1 (WC). MONTROSE COUNTY: Coventry, 6800 ft., 8 (3 USNM, 5 WC); *Maverick Canyon, Coventry, 6800 ft.,* 1 (WC). SAGUACHE COUNTY: North Tracy Canyon, SW of Saguache, 1 (ASC); San Juan Cañon, 8 mi. S, 5 mi. W Saguache, 1 (ASC). LA PLATA COUNTY: Bondad, 1 (USNM).

Additional records (Van Gelder, 1959:288, unless otherwise noted): MOFFAT COUNTY: 35 mi. below Bagg's Crossing, Little Snake River (Cary, 1911:181); Sunny Peak (Warren, 1942:81). RIO BLANCO COUNTY: *"Upper White River country,"* (Felger, 1910:145). GARFIELD COUNTY: New Castle (Cary, 1911:181). BOULDER COUNTY: *Halfway House, Flagstaff Mountain.* DENVER COUNTY (probably Park County): *South Park.* MESA COUNTY: (P. H. Miller, 1964:90): Headquarters Residence Area, Colorado National Monument, 5780 ft.; *2 mi. E Visitors' Center, Colorado National Monument.* DOUGLAS COUNTY: *Goose Creek* (not found); "*. . . possibly at Sedalia*" (Warren, 1942:80). EL PASO COUNTY: *Fountain* (Coues, 1877:240); *Bear Creek Cañon, 7500 ft.* FREMONT COUNTY: *18 1/2 mi. S Lake George;* 20 mi. S Lake George. HUERFANO COUNTY: Muddy and Huerfano valleys (Cary, 1911:180). ALAMOSA COUNTY: near Mosca Pass (Cary, 1911:180). MONTEZUMA COUNTY: Ashbaugh's Ranch [Moqui], 5200 ft.; Mesa Verde National Park (Anderson, 1961:60). LA PLATA COUNTY: vicinity of Bayfield (Cary, 1911:181). COSTILLA COUNTY: 5 mi. SSE Fort Garland. BACA COUNTY: Furnace [Furnish] Canyon.

Spilogale putorius interrupta (Rafinesque)

Mephitis interrupta Rafinesque, Ann. Nat., 1:3, 1820; type locality, "Louisiana" (restricted to Upper Missouri River by Lichtenstein—see Van Gelder, 1959:269-270).

Spilogale putorius interrupta, McCauley, Texas Jour. Sci., 4:108, 30 March 1952.

Distribution in Colorado.—To an undetermined extent on plains of eastern one-third of state (Fig. 105).

Comparison.—For comparison with *S. p. gracilis,* see account of that subspecies.

Measurements.—External measurements of a male from Wray, Yuma County, are: 485, 200, 52. Average (and extreme) cranial measurements of eight males, followed by those of four females, all from Wray, are: condylobasal length, 56.00 (53.3-58.3), 52.73 (48.9-55.3); zygomatic breadth, 33.25 (31.4-35.4), 31.30 (30.6-32.8); interorbital constriction, 15.00 (13.7-16.0), 14.70 (13.8-15.9); postorbital constriction, 14.81 (13.9-16.0), 15.15 (15.0-15.4); mastoid breadth, 29.50 (28.0-31.2), 28.90 (28.0-30.0); length of maxillary toothrow, 18.08 (17.3-18.8), 17.85 (17.2-18.2) (Van Gelder, 1959:274).

Remarks.—Cary (1911:180) attributed to D. Lantz a report that spotted skunks were common in the vicinity of Hugo, Lincoln County. In the absence of specimens from that or nearby localities, Hugo is not plotted in Fig. 105.

Records of occurrence.—Specimens examined, 2, distributed as follows: YUMA COUNTY: Wray, 1 (WC). PROWERS COUNTY: 10 mi. S Lamar, 1 (FWS).

Additional records: MORGAN COUNTY: near Fort Morgan (Van Gelder, 1959:272). LINCOLN COUNTY: *Hugo* (Cary, 1911:180)—see remarks above).

Mephitis mephitis

Striped Skunk

Mephitis mephitis has the broadest ecological range of Coloradan skunks, and over much of the state it is the most abundant species. The range of the striped skunk is essentially statewide, to altitudes above 10,000 feet, but greatest numbers occur at lower elevations, particularly in agricultural areas. The animals den in burrows, rock shelters, and in or beneath buildings.

No study of the ecology of *M. mephitis* in Colorado has been made. The species is abundant locally, however, and such a study is to be encouraged. Perhaps the abundance of striped skunks is a consequence of settlement; as omnivores, striped skunks thrive in close proximity to man. The association of skunks with settled areas was noted by Coues (1877: 216): "I was struck with this circumstance during my recent travels in Colorado, where Skunks were a never-failing nuisance about the ranches, though I never saw or smelled one . . . in the uninhabited mountains of that state." Later, Coues (1879:220) wrote of *M. mephitis:* "This animal is far too numerous in Colorado, especially about the settlements in the foot-hills and on the prairie."

The legal status of skunks in Colorado recently was changed from that of "predator" to "non-game mammal." As such, Coloradan skunks are subject to licensed hunting or trapping without limit throughout the year. Skunks are killed by representatives of the Branch of Predator and Rodent Control, Bureau of Sport Fisheries and Wildlife. In 1962, 524 skunks were reported taken, but probably that figure is unrealistic, because only 18 animals were reported to have been poisoned. Poisoning of skunks with poisoned eggs is a common practice in Colorado, in areas where they are supposed to be important nest predators on game birds. A quantitative study of the effects of skunks on populations of game birds never has been undertaken in the state, however.

Fur-buyers reported handling an average of 260 skins of skunks annually over the 10-year period 1958-1967 (range, 101 in 1961 to 402 in 1965). Probably most of those skins were of *M. mephitis,* inasmuch as the few skins of *Spilogale putorius* marketed are reported as "civet cat," and numbers of *Conepatus mesoleucus* are thought to be low in Colorado.

Geographic variation in the striped skunk is under study by Dr. R. G. Van Gelder of the American Museum of Natural History. The most recent previous revision (A. H. Howell, 1901) is typological in its approach and is based on generally inadequate material; it has proved to be of only marginal usefulness in study of the distribution of *Mephitis mephitis* in Colorado. Hall (1936:64) summarized information gained since Howell's revision and concluded that all named kinds in the subgenus *Mephitis* (*sensu* Howell) are, in fact, subspecies of a single species. Systematic study of striped skunks is made difficult by the fact that most collections contain few if any skins of these animals. The paucity of skins doubtless stems from the value (at least formerly) of the pelt, and the obvious inconvenience of preparing specimens potentially so malodorous.

Howell (1901) referred Coloradan striped

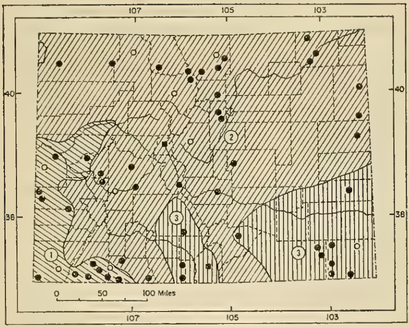


FIG. 106. Distribution of *Mephitis mephitis* in Colorado. 1. *M. m. estor.* 2. *M. m. hudsonica.* 3. *M. m. varians.* For explanation of symbols, see p. 9.

skunks to two species, "*Chincha hudsonica*" and "*Chincha mesomelas.*" A third nominal species, "*Chincha estor,*" was ascribed a range in the desert Southwest. Perhaps Howell later came to modify his position. Warren (1942:75) stated: "A. H. Howell . . . has recently examined my series of skunks, and writes me that he has come to the conclusion that there is only one species of skunk [in Colorado]." Cary (1911:178) treated striped skunks in Colorado as two species, *Mephitis hudsonica* and *Mephitis mesomelas,* the latter represented by two subspecies, *varians* and *estor.*

Mephitis mephitis estor Merriam

Mephitis estor Merriam, N. Amer. Fauna, 3:81, 11 September 1890; type locality, Little Spring, 8200 ft., N base of San Francisco Mountain, Coconino Co., Arizona.

Mephitis mephitis estor, Hall, Univ. California Publ. Zool., 37:1, 10 April 1931.

Distribution in Colorado.—Southwestern part of state (Fig. 106).

Comparisons.—From both *M. m. hudsonica* and *M. m. varians,* the subspecies *estor* differs in smaller external and cranial size and in more extensive white markings.

Measurements.—External measurements of a male from Coventry, Montrose County, are: 764, 312, 86. Mean (and extreme) cranial measurements of five males, followed by those of five females, all from La Plata County, are: condylobasal length, 75.20 (73.4-76.5), 69.46 (69.3-70.9); zygomatic breadth, 48.84 (46.4-50.6), 44.70 (43.5-45.5); postorbital constriction, 19.02 (16.7-20.4), 18.56 (18.2-19.3); mastoid breadth, 41.10 (39.4-42.7), 37.60 (36.0-39.0); length of maxillary toothrow, 21.98 (21.3-22.4), 21.24 (20.3-21.9).

Remarks.—Durrant (1952:432) tentatively referred to *M. m. estor* two immature individuals from Uintah County, Utah, judged by him to be intergrades between *M. m. estor* and *M. m. major.* I have examined but a single specimen from that area of western Colorado between the Colorado and Yampa rivers, but suspect that *estor* will be found to extend little if any north of the Grand Valley in Colorado. Specimens from Delta and Gunnison counties are judged by me to be intergrades between *estor* and *hudsonica.* A single skull from northern Delta County is referred to *estor* following Anderson (1959a: 413). Specimens from southern Delta County and Gunnison County seem to me to be best assigned to *hudsonica.*

Records of occurrence.—Specimens examined, 56, distributed as follows: MESA COUNTY: Headquarters, Colorado National Monument, 1 (CNM); *Warehouse, Colorado National Monument,* 1 (CNM). DELTA COUNTY: 1/2 mi. S, 8 mi. E Skyway, 1 (KU). MONTROSE COUNTY: La Sal Mountains, 1 (DMNH); West Paradox Valley, 9 (DMNH); Coventry, 4 (WC); San Miguel Cañon, Coventry, 3 (USNM). SAN MIGUEL COUNTY: "*Norwood (Coventry),*" 4 (SC). MONTEZUMA COUNTY: Four Corners, 1 (DMNH). LA PLATA COUNTY: Florida River, 2 (USNM); Ute Creek, [near] Durango, 1 (USNM); Mesa, Pine [Los Piños] River, 10 (USNM); Pine [Los Piños] River, 5 (USNM); La Plata River, 7 (USNM); Bondad, 1 (DMNH); Allison, 2 (UNM). ARCHULETA COUNTY: *Piedra River,* 1 (USNM); mouth of Sandoval Cañon, 1 (UNM); *no locality other than county,* 1 (DMNH).

Additional records: MESA COUNTY: 9 mi. S, 1 mi. W Glade Park P. O., 8800 ft. (sight record, DMA field notes, 6 August 1969). MONTEZUMA COUNTY: Mesa Verde National Park (sight records, Anderson, 1961:60). ARCHULETA COUNTY: 10 mi. N Arboles (Durrant and Dean, 1961: 178).

Mephitis mephitis hudsonica Richardson

Mephitis americana var. *hudsonica* Richardson, Fauna Boreali-Americana, 1:55, 1829; type locality, plains of the Saskatchewan River.

Mephitis mephitis hudsonica, Hall, Univ. California Publ. Zool., 40:368, 5 November 1934.

Distribution in Colorado.—Northeastern part of state and mountains and high plateaus of central and northwestern Colorado (Fig. 106).

Comparisons.—From *M. m. varians,* the subspecies of the southern Great Plains, *M. m. hudsonica* differs in larger size and more extensive white markings on the tail. For comparison with *M. m. estor,* see account of that subspecies.

Measurements.—External measurements of two males and a female from Yuma County are: 640, 745, 640; 285, 320, 285; 75, 75, 75. Average (and extreme) cranial measurements of 16 males, followed by those of 11 females, all from Arkins, Larimer County (see remarks beyond), include: condylobasal length, 77.38 (73.4-82.9), 69.96 (68.3-71.7); zygomatic breadth, 50.19 (44.8-52.6), 44.44 (43.2-46.2); postorbital constriction, 19.24 (17.4-19.9), 18.24 (17.0-19.9); mastoid breadth, 42.49 (37.8-45.9), 37.72 (35.4-39.6). Selected cranial measurements of four males from Yuma County and two males from the vicinity of Colorado Springs are: condylobasal length, 76.2, 73.5, 72.8, 78.8, 76.9, 79.2; zygomatic breadth, 48.0,47.2, 44.2, 48.1, —, 49.8; postorbital constriction, 19.1, 19.3, 18.2, 18.7, 21.1, 19.6; mastoid breadth, 41.5, 39.3, 37.6, 41.8, 42.9, 43.3; length of maxillary toothrow, 22.1, 21.3, 21.7, 22.7, 20.8, 22.7.

Remarks.—Long (1965:702) treated all striped skunks from Wyoming as a single subspecies (*M. m. hudsonica*) without comment. Cockrum (1952:255) referred specimens from Kansas west of about 98° to *M. m. varians.* Jones (1964:293-295) documented apparent clinal variation in the size of striped skunks in western Nebraska. It was noted that specimens from northwestern and north-central Nebraska were representative of *hudsonica* as typified by A. H. Howell (1901:24, 41), whereas specimens from south of the Platte River averaged smaller and somewhat longer-tailed, therein approaching *varians* to some extent. All Nebraskan striped skunks were, however, treated as a single subspecies, *M. m. hudsonica.*

Material from the plains of eastern Colorado is generally inadequate. Specimens from Yuma County (KU 116879-80, unsexed skulls only, supposed by me on the basis of size to be males) are comparable in size to that reported by Jones (*op. cit.*:295) for specimens from Dundy County, Nebraska. These are considered by me to be intergrades between *hudsonica* and *varians,* referable to the former subspecies.

A. H. Howell (*op. cit.*:25) noted that *hudsonica* was not known to intergrade with *varians.* Of importance to that conclusion was a series of specimens from Arkins, Larimer County. Arkins was a quarrying town, on an abandoned branch of the Colorado and Southern Railway, NE 1/4 sec. 2, T. 5 N, R. 70 W, some 3 mi. N and 7 mi. W of Loveland. Specimens from Arkins were taken by Howell to indicate that ". . . two species are present in that region. Of 31 skulls of adult males, 16 are fairly typical *hudsonica,* 12 are just as typical *varians,* and 3 are indeterminate. . . . Under these rather unusual conditions it seems hardly possible to consider that the two species intergrade, but rather that their ranges overlap at this point, each remaining distinct, save for an occasional hybrid."

The series of skulls (no skins were found by me in March 1969) from Arkins is indeed remarkably variable. It was the largest series of specimens available to Howell (1901) from the western part of the continent. The range of variability is illustrated by the selected cranial measurements presented above. However, for two reasons I am inclined to discount the usefulness of this series of specimens. In the first place, of specimens labelled "*hudsonica,*" only one is designated a female, but there are 16 males. On labels of specimens catalogued as "*varians*" the designation of sex has been changed in a number of instances. Considering the marked differences in size between sexes and between the taxa under consideration, the fact that designations of sex have been altered may be of importance. That a museum worker (possibly Howell) should doubt the accuracy of a collector leads one to doubt the utility of the specimens.

Secondly, whether or not all specimens actually were collected at Arkins is perhaps open to question. The material was collected by R. S. Weldon about 1896 and forms part of a considerable collection of mammals from Arkins (mostly odd skulls of carnivores) in the United States National Museum. Among the specimens labelled "Arkins" is a marten, *Martes americana* (USNM 69967). I doubt that the marten ever ranged into the ecological situation of Arkins—an open valley between hogback ridges supporting only a scattered growth of *Pinus ponderosa* and shrubs. I suspect that the eastern limit of the range of the marten at the latitude of Arkins is some 10 to 15 miles to the west of that place, and perhaps 3500 feet higher in elevation.

The series of skunks labelled "Arkins" may, in fact, represent two generally distinct populations as outlined by Howell (*loc. cit.*). The general vicinity of Arkins, near the confluence of Buckhorn Creek and the Big Thompson River, is that kind of area wherein one comes to expect complex relations between populations of mammals adapted to the plains and those adapted to the highlands. If the specimens in question are from the general vicinity of Arkins (within 5 to 10 miles, say) and not from Arkins proper, it is easy to imagine the close proximity of populations of larger skunks of the mountains and northern Great Plains (*hudsonica*) and populations of smaller skunks from the southeast (*varians*) with minimal genetic communication.

Since the material from Arkins is equivocal, the sample is herein considered to represent a single species from a single locality (the latter with considerable reservation). Because of the variation observed in the sample, I am inclined to regard specimens from Arkins as intergrades between *hudsonica* and *varians*, although clearly referable to the former subspecies. It is apparent to me, however, that the solution offered here is a pragmatic but unimaginative answer to an obviously complex and interesting problem. It is a problem that cannot be answered adequately with the material at hand, but will require thorough survey of the populations in the field.

Records of occurrence.—Specimens examined, 98, distributed as follows: MOFFAT COUNTY: 9 1/2 mi. E Craig, 1 (CU); S bank Yampa River, 5 mi. NW Cross Mountain, 1 (AMNH). JACKSON COUNTY: Spicer, 1 (USNM). LARIMER COUNTY: 3 mi. S Fort Collins, 1 (CSU); 1/2 mi. W Timnath, 1 (CSU); Arkins, 46 (USNM); *Loveland*, 1 (USNM); Estes Park, 1 (RMNP); *1 mi. SW Estes Park*, 1 (RMNP); *no locality other than county*, 1 (CSU). LOGAN COUNTY: 3 1/2 mi. S, 9 1/2 mi. W Peetz, 1 (KU); Sterling, 1 (USNM); 10 mi. SE Sterling, 1 (USNM). GRAND COUNTY: Kawuneeche Residence Area, 1 (RMNP); *Pontiac Lodge area*, 1 (RMNP); Grand Lake, 8367 ft., 1 (CSU). BOULDER COUNTY: *6 mi. N Boulder*, 1 (RMNP); Boulder, 8 (6 CU, 1 FMNH, 1 FWS); *Flagstaff Mountain*, 1 (CU); *no locality other than county*, 1 (USNM). JEFFERSON COUNTY: Golden, 1 (DMNH); Morrison Road at Smith Road, 1 (DMNH). YUMA COUNTY: Wray, 3 (WC); Bonny Dam, 2 mi. W Hale, 2 (KU). LAKE COUNTY: no locality other than county, 1 (ASC). KIT CARSON COUNTY: Burlington, 1 (UMMZ). DELTA COUNTY: Crawford, 1 (WC). GUNNISON COUNTY: Crested Butte, 2 (1 KU, 1 WSC); *Ohio Creek, 6 mi. N Gunnison*, 1 (WSC); Gunnison, 1 (WSC). CHAFFEE COUNTY: Salida, 1 (WC). EL PASO COUNTY: N of Colorado Springs, 2 (WC). MONTROSE COUNTY: Maher, 2 (WC). FREMONT COUNTY: Cañon City, 1 (USNM). ARCHULETA COUNTY: Gordon Creek, near Piedra River, 1 (UNM); *Navajo River*, 4 (DMNH); Chromo, 1 (DMNH).

Additional records: ROUTT COUNTY: California Park (Felger, 1910:145). LARIMER COUNTY: Laporte (Yeager and Woloch, 1962:420). GRAND COUNTY: Williams Fork Road (Gilbert and Hill, 1960:139). PARK COUNTY: South Park (J. A. Allen, 1874:54); *Mount Lincoln* (Blake and Blake, 1969:37). GUNNISON COUNTY (Durrant and Robinson, 1962:256): 1 mi. above junction Red Creek and Gunnison River, 7350 ft.; *Cebolla Creek, 1 1/2 mi. from Gunnison River.*

Mephitis mephitis varians Gray

Mephitis varians Gray, Charlesworth's Mag. Nat. Hist., 1:581, 1837; type locality, Texas.

Mephitis mephitis varians, Hall, Carnegie Inst. Washington Publ., 473:66, 20 November 1936.

Distribution in Colorado.—Plains of southeastern part of state and in San Luis Valley (Fig. 106).

Comparisons.—For comparisons with other Coloradan subspecies, see accounts of those taxa.

Measurements.—External measurements of a male and a female from northwestern Baca County are: 720, 648; 337, 292; 75, 64. Mean (and extreme) cranial measurements of four males, followed by those of four females, all from Baca County, include: condylobasal length, 76.45 (73.8-79.4), 69.15 (67.9-70.3); zygomatic breadth, 47.20 (44.1-49.5), 44.95 (43.1-46.2); postorbital constriction, 20.45 (18.5-22.5), 18.37 (17.3-19.4); mastoid breadth, 39.77 (38.5-41.3), 37.57 (34.2-39.2);

length of maxillary toothrow, 22.80 (22.2-23.7), 21.45 (20.6-22.3).

Remarks.—Intergradation between *M. m. hudsonica* and *M. m. varians* apparently occurs over much of eastern Colorado. In fact, geographic variation might better be described in terms of clines than by subspecific distinctions which, in the present case, are patently typological. Available material, however, does not allow description of such clines, and the recognition of subspecies seems to me to be the conservative course. The only series of specimens from southeastern Colorado sufficiently large to allow even tentative assessment of individual variation is that from Baca County. Those specimens average larger than *varians* from southern Texas and Tamaulipas (A. H. Howell, 1901:44), but generally are smaller than other specimens from eastern Colorado, and are markedly smaller than specimens of *hudsonica* from farther to the north.

Records of occurrence.—Specimens examined, 25, distributed as follows: SAGUACHE COUNTY: 5 mi. NW Hooper, 3 (DMNH); *Hooper,* 1 (DMNH). KIOWA COUNTY: Chivington, 1 (USNM). HUERFANO COUNTY: Huerfano Butte, 1 (CU). CONEJOS COUNTY: La Jara, 1 (USNM); Antonito, 1 (USNM). COSTILLA COUNTY: no locality other than county, 3 (USNM). LAS ANIMAS COUNTY: Irwin's Ranch [T. 29 S, R. 52 W], 5000 ft., 1 (WC); 25 mi. NW Estelene, 1 (USNM). BACA COUNTY: Gaume's Ranch, 2 (WC); Estelene [sec. 16, T. 33 S, R. 50 W], 6 (USNM); Furnace [Furnish] Canyon, 2 (DMNH); *Jimmie Creek,* 1 (DMNH); Regnier, 1 (DMNH).

Additional records: PROWERS COUNTY: *Conrow* (not found) (Howell, 1901:32). BACA COUNTY: Two Buttes (Finley, 1959:594).

Conepatus mesoleucus

HOG-NOSED SKUNK

The hog-nosed skunk is a mammal of México and parts of the southwestern United States. Records from southeastern Colorado mark the northern extreme of the range of the species. When *Conepatus mesoleucus* first was reported from the state (Warren, 1921), the record represented an extension of the known range of the species by some 300 linear miles, from the vicinity of Albuquerque, New Mexico.

Farther south, hog-nosed skunks typically inhabit desert valleys and canyons in low mountain ranges. In Colorado, records are from canyonlands, frequently about stands of piñon. The diet consists mostly of ground-dwelling insects, and *C. mesoleucus* probably is of positive economic value where it is abundant.

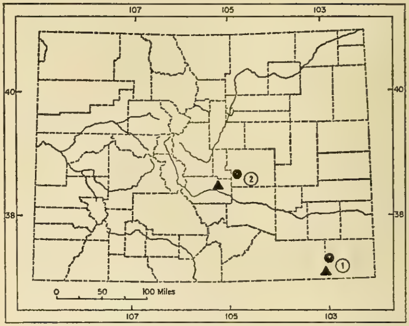


FIG. 107. Distribution of *Conepatus mesoleucus* in Colorado. 1. *C. m. figginsi.* 2. *C. m. fremonti.* For explanation of symbols, see p. 9.

Conepatus mesoleucus figginsi F. W. Miller

Conepatus mesoleucus figginsi F. W. Miller, Jour. Mamm., 6:50, 9 January 1925; type locality, Furnace [Furnish] Canyon, Baca County, Colorado.

Distribution in Colorado.—Known only from western Baca County (see Fig. 107 and remarks below).

Comparison.—See remarks below.

Measurements.—External measurements of the holotype (a male, DMNH 1961) are: 734, 232, 77. Representative cranial measurements of a male (DMNH 1961) and a female (DMNH 2373) from Baca County are: condylobasal length, 76.3, —; zygomatic breadth, 54.0, 47.5; interorbital constriction, 26.0, 24.6; mastoid breadth, 45.3, —; length of maxillary toothrow, 21.1, 22.0.

Remarks.—To date only eight specimens of *C. mesoleucus* are available for study from Colorado; obviously this is a sample too small to allow an appreciation for individual variation within a population. That two subspecies have been recognized on the basis of the meager Coloradan material at hand seems to me to represent a confusion of individual variation with geographic variation.

F. W. Miller (1925:50) characterized *C. m. figginsi* as follows: "A large northern race of the *mesoleucus* group most nearly allied to *C. m. mearnsi.* Skull more massive and rugged and differing in detail." The skull was noted to differ from that of *mearnsi* in: 1) larger size, greater angularity and ruggedness; 2) pronounced sagittal and occipital crests; 3) more widely spreading zygomata; 4) greater mastoid breadth; 5) narrower pterygoid fossa; 6) inflated frontals and "postorbitals" (processes?); 7) heavier dentition. The "extreme depth of the skull with mandibles in situ . . ." (depth of muzzle) was seen as particularly noteworthy (*op. cit.*:51).

Conepatus m. fremonti was compared by Miller (1933a:1) with *C. m. figginsi* and *C. m. mearnsi,* and was said to differ from them in cranial details (such as well developed spine on the posterior margin of the palate, and a heart-shaped, rather than U-shaped, interpterygoid fossa, measuring more than twice as long as broad).

I have reviewed the original description of *figginsi* as well as notes made by me on the holotype and two additional skulls from Baca County. For comparison, I have used three skulls of males from Coahuila and Tamaulipas representing *C. m. mearnsi.* In every case, the characters supposed by Miller (1925) to be diagnostic of *figginsi* are to be found within the range of variation of the small sample of *mearnsi* studied, and seem to me to reflect the age (and sex) of the holotype. The other specimen available to Miller (DMNH 1964—the number apparently was transposed by Miller, 1933a:3) also is a male, somewhat smaller than the holotype and less rugose cranially. That skull was not found in the Denver Museum in 1969 or 1970. Similarly, characters presented as distinguishing *C. m. fremonti* from other named kinds (Miller, 1933a) are matched in the small series of *mearnsi* available.

Whether *C. m. figginsi* and *C. m. fremonti* are in fact synonyms of the earlier-named *C. m. mearnsi* is to be judged only after thorough study of individual and geographic variation throughout the range of the species. Such a study currently is being made by Dr. R. G. Van Gelder of the American Museum of Natural History (see Van Gelder, 1968). For purposes of the present checklist I regard both *figginsi* and *fremonti* as insignificantly different from *mearnsi* (as understood by me), and therefore accord the two nominal subspecies no zoogeographic importance.

Warren (1942:82) gave as the distribution of *C. m. figginsi* the following: "Furnace Cañon, Baca County; Keaton Ranch, Little Fountain Creek, 12 mi. southwesterly from Colorado Springs. The Colorado Museum of Natural History [now Denver Museum of Natural History] has one from somewhere near Cañon City." In the account of *C. m. fremonti,* Warren (*op. cit.*:83) noted that "besides the type specimen [from near Cañon City] Miller considers a skull in my own collection from Little Fountain Creek . . . as belonging to this subspecies. . . ." This juxtaposition of the ranges of *figginsi* and *fremonti* is an obvious *lapsus;* I know of but one specimen each from both Little Fountain Creek and the vicinity of Cañon City. The above-mentioned error was perpetuated by Hall and Kelson (1959:940-941).

Records of occurrence.—Specimens examined, 6, distributed as follows: BACA COUNTY: Furnace [Furnish] Canyon, 5 (DMNH); *western Baca County,* 1 (DMNH).

Conepatus mesoleucus fremonti F. W. Miller

Conepatus mesoleucus fremonti F. W. Miller, Proc. Colorado Mus. Nat. Hist., 12:1, 22 July 1933; type locality, Garden Park, near Cañon City, Fremont Co., Colorado.

Distribution in Colorado.—Known only from El Paso and Fremont counties (see Fig. 107 and remarks in the account of *C. m. figginsi,* above).

Comparison.—See remarks in the account of the preceding nominal race.

Measurements.—External measurements of the holotype (a male, DMNH 2506) are: 705, 255, 55 (measured from the dry skin, *fide* Miller, 1933a:1). Selected cranial measurements of the holotype include: condylobasal length, 68.7; zygomatic breadth, 45; least interorbital constriction, 19.4; mastoid breadth, 37 (*op. cit.*:3).

Remarks.—Garden Park, the type locality, is a fossil quarry in the canyon of Fourmile Creek (also called Oil Creek), about 10 mi. N of Cañon City. For comments on the status of the nominal subspecies *C. m. fremonti* and *C. m. figginsi,* see the account of the latter race.

I have searched unsuccessfully in the Denver Museum of Natural History for the skull of the holotype of *C. m. fremonti* (DMNH 2506) on two occasions, in April 1969 and in March 1970.

Records of occurrence.—Specimens examined, 2, distributed as follows: EL PASO COUNTY: Keaton Ranch, Little Fountain Creek, 1 (WC). FREMONT COUNTY: Garden Park, 1 (DMNH).

Lutra canadensis

River Otter

The otter originally ranged over most of North America north of Mexico, except for the desert Southwest and the Arctic Islands. Over the southern part of its former range, the species has been extirpated or greatly reduced in numbers. Although records are available from every major drainage in Colorado, there is no evidence that *Lutra canadensis* ever was abundant in the state. Coues (1879:221) noted: "The otter appears to be a rare animal in Colorado. I did not find any sign of its presence during my tour of that state in 1876, and the single specimen in the [Maxwell] Collection was the only one of which Mrs. Maxwell had known." Warren (1906:265) speculated that the variable flow of mountain streams might explain the paucity of otters in the mountains of Colorado. Today, those parts of the state that present habitat otherwise suitable for otters probably are too heavily populated to allow the animals to occur. I doubt that the otter now exists in Colorado, save perhaps as occasional wandering individuals.

The only specimens of *L. canadensis* that I have examined from Colorado are old skins in poor condition, and such material is no basis for assessing geographic variation. Hall and Kelson (1959:947) assigned records of otters in Colorado to three subspecies. That assignment can only have been made on geographic grounds, because to my knowledge but four specimens have been preserved from the state—the two listed below as examined, one reported by Coues (1877:312), and an odd skull from Pueblo said by Cary (1911:183) to have been in the United States National Museum, but not found by me. All other Coloradan records are based on observations. For the purposes of the present checklist, mapping ranges of subspecies of *L. canadensis* is not attempted. Based on the arrangement of Hall and Kelson (*loc. cit.*), five nominal subspecies might have been expected occasionally in Colorado. Those are: 1) *L. c. canadensis,* a subspecies of north-central and northeastern United States and adjacent Canada (perhaps the subspecies in North Park); 2) *L. c. interior,* a subspecies of the lower Missouri and Arkansas drainages (probably the subspecies of the eastern part of the state); 3) *L. c. texensis,* a subspecies of the Red River drainage of Texas and adjacent states (perhaps in extreme southeastern Colorado); 4) *L. c. sonora,* a subspecies ascribed a range in the Colorado and upper Rio Grande drainages (probably the subspecies of west-central Colorado and perhaps in the San Luis Valley); 5) *L. c. nexa,* a subspecies of the Middle Rocky Mountains (perhaps the subspecies of the mountains of Colorado).

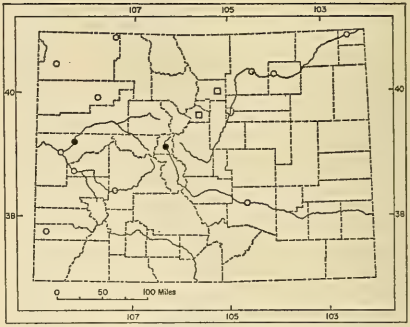


FIG. 108. Distribution of *Lutra canadensis* in Colorado. For explanation of symbols, see p. 9.

Records of occurrence.—Specimens examined, 2, distributed as follows (Fig. 108): GRAND COUNTY: Grand [Fork of Colorado] River, 1 (DMNH). LAKE COUNTY: headwaters of the Arkansas River, 1 (WC).

Additional records (Warren, 1942:72, unless otherwise noted): MOFFAT COUNTY (Cary, 1911: 182): [Little] Snake River, within a few miles of Slater; Yampa Canyon, Bear [Yampa] River. WELD COUNTY: Platte River, E of Greeley (Warren, 1906:265). MORGAN COUNTY: South Platte River, near Orchard. SEDGWICK COUNTY: near

Julesburg (Warren, 1906:265). RIO BLANCO COUNTY: White River Valley (Felger, 1910:146). BOULDER COUNTY: no precise locality (Coues, 1877:312). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:224). MESA COUNTY: Grand Junction. DELTA COUNTY: Gunnison River, below Delta. GUNNISON COUNTY: Gunnison River, near Sapinero (Warren, 1908b:84). DOLORES COUNTY: Big Dolores River (Warren, 1906:265). PUEBLO COUNTY: Pueblo (Cary, 1911:183).

FAMILY FELIDAE—CATS

KEY TO SPECIES OF FELIDAE IN COLORADO

1. Tail long, more than one-third total length; condylobasal length greater than 150 .... *Felis concolor*
   Tail short, less than one-fifth total length; condylobasal length less than 125 2
2. Tail less than one-half length of hind foot, tip of tail black above and below; jugular foramen not confluent with anterior condyloid foramen .... *Lynx canadensis*
   Tail more than one-half length of hind foot, tip of tail black above, white below; jugular foramen confluent with anterior condyloid foramen .... *Lynx rufus*

Felis concolor

MOUNTAIN LION

The geographic range of *Felis concolor* is larger than that of any other native New World mammal, extending from northern British Columbia southward to southern Argentina. In Colorado, the mountain lion may formerly have ranged statewide, although in the eastern part of the state the species must have been restricted to riparian situations or rocky habitats. *Felis concolor* hunts by stealth, a mode of predation poorly adapted to open country.

Most available records are from the mountainous portions of Colorado. On the Eastern Slope, populations were reduced in the early years of settlement, and may never have been as large as those on the Western Slope. About 1900, parts of western Colorado supported the best populations of mountain lions in the United States. President Theodore Roosevelt hunted lions out of Meeker in 1901 (see Roosevelt, 1901 and Merriam, 1901). Since that time populations have declined over the entire state. Cahalane (1948:251) discussed the decline in Dinosaur National Monument. Cary (1911:163-165) presented detailed notes on distribution and abundance of lions in Colorado. S. P. Young (1946) discussed the natural history and status of *F. concolor* over its range, including a considerable amount of data on Coloradan animals.

Presently the area of greatest abundance of mountain lions is the northwestern part of the state, generally that area north of the Colorado Valley and west of Rifle and Meeker. Other areas in which lions still occur commonly are the vicinity of Pagosa Springs, the upper South Platte drainage, and the lower slopes of the Sangre de Cristo Range and the Wet Mountains (unpublished data, Division of Game, Fish and Parks).

Because of occasional depredation against livestock, particularly horses, mountain lions were subject to bounty-hunting in Colorado for many years. Lechleitner (1969:206) and Coleman (1965) discussed the bounty system and its effects. Over the period 1957 through 1965, bounties paid on lions amounted to $22,850 (Colorado Big Game Harvest, 1969: 12). In 1965, the bounty was removed and *F. concolor* was declared a game animal, subject to licensed hunting. Hopefully under the new status, lions will be allowed to increase over at least a part of their former range in Colorado. An increase in natural predation would be to the benefit of high populations of mule deer in the western part of the state.

Felis concolor hippolestes Merriam

Felis hippolestes Merriam, Proc. Biol. Soc. Washington, 11:219, 15 July 1897; type locality, near head of Big Wind River, Wind River Mountains, Fremont Co., Wyoming.

Felis concolor hippolestes, Nelson and Goldman, Jour. Mamm., 10:347, 11 November 1929.

Distribution in Colorado.—Formerly perhaps statewide in suitable habitat; presently restricted to western three-fifths of state, and most abundant at moderate elevations on Western Slope (Fig. 109).

Comparisons.—From *F. c. azteca* and *F. c. kaibabensis*, subspecies with ranges to the south and west of Colorado, *F. c. hippolestes* differs in generally larger size; *hippolestes* is

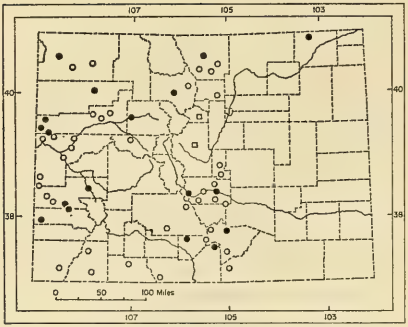


FIG. 109. Distribution of *Felis concolor hippolestes* in Colorado. For explanation of symbols, see p. 9.

darker in color than *kaibabensis* and the dark area of the mid-dorsum is more clearly defined (see Goldman, 1946:209).

Measurements.—External measurements of a male from Grand County are: 2105, 803, 292, 105. Additional measurements are presented by Merriam (1901) and by Goldman (1946:210). Cranial measurements of two males from Moffat County, a male from San Miguel County, a female from Garfield County, and a female from Mesa County are, respectively: condylobasal length (measured with metric ruler), 202, 187, 189, 168, 164; zygomatic breadth, 148.2, 147.6, 138.8, 127.2, 128.0; interorbital constriction, 42.0, 43.6, 42.8, 38.7, 36.4; postorbital constriction, 37.7, 44.1, 45.2, 38.2, 42.7; mastoid breadth, 64.4, 59.9, 63.5, 56.0, 55.0; length of nasals, 59.8, 60.2, 65.2, 52.6, 53.1; length of maxillary toothrow, 64.4, 59.9, 63.5, 56.0, 55.0. For additional cranial measurements, see Merriam (*loc. cit.*) or Goldman *(loc. cit.)*.

Remarks.—The only specimens seen by me from the plains of eastern Colorado are two sets of mandibles, both labelled "30 mi N Sterling," and catalogued together as KU 2789. The locality is in the rough terrain marking the boundary between the Colorado Piedmont and the High Plains. The material was "picked up" by H. T. Martin in 1911. Both sets of mandibles are considerably weathered, and one is apparently rodent-chewed and lightly encrusted with lichen. Both specimens obviously are of Recent age. Alveolar lengths of mandibular toothrow of these individuals are: 73.5, 68.1.

A number of specimens in the University of Colorado Museum and reported by Goldman (1946:211) are labelled with the hometown of the collector rather than with the locality of collection. The skulls were donated to the Museum by the Denver *Post*, and were voucher specimens in a "contest" conducted in 1937 and 1938 to find the largest lion in Colorado. Typewritten notes had been placed inside most of the skulls giving details of collection, and localities noted there are used in preference to those indicated on specimen labels and reported by Goldman.

Felis c. hippolestes may intergrade with *F. c. aztecus* in southwestern Colorado, but specimens to substantiate that possibility are lacking.

Records of occurrence.—Specimens examined, 41, distributed as follows: MOFFAT COUNTY: Greystone, 2 (CU); *Douglas Spring*, 2 (WC). LARIMER COUNTY: Bennett Creek, 8500 ft., 1 (CSU). LOGAN COUNTY: 30 mi. N Sterling, 2 (KU). RIO BLANCO COUNTY: Meeker, 11 (USNM); *West Creek* (not found), 2 (USNM); *Rathole Canyon* (not found), 1 (CU). GARFIELD COUNTY: Douglas Pass, 1 (CSU); Atchee, 1 (CU). EAGLE COUNTY: Dotsero, 4 (KU). GRAND COUNTY: near Parshall, 1 (CU). MESA COUNTY: Sphinx Canyon, 20 mi. N Loma, 1 (CU). MONTROSE COUNTY: Montrose, 1 (WC); W of Redvale, 1 (USNM). SAN MIGUEL COUNTY: 2 mi. NE Norwood, 7079 ft., 1 (CSU); Dolores River Canyon, 1 (CU). FREMONT COUNTY: Cañon City, 2 (USNM); 12 mi. NW Cotopaxi, 1 (CSU); West Creek, SW of Howard, 1 (CU). ALAMOSA COUNTY: Hooper, 1 (DMNH). HUERFANO COUNTY: "Greenhorn Mountain country," 1 (USNM). COSTILLA COUNTY: head of West Indian Creek, 1 (CU). County unknown: *Karren Ridge*, 1 (USNM).

Additional records (CU catalog, specimen not found, unless otherwise noted): MOFFAT COUNTY: Maybell (Goldman, 1946:211); near Lily. LARIMER COUNTY: Jug Gulch, 12 mi. NW Loveland (Young, 1946:55); N of Estes Park; Drake (Goldman, 1946:211). GARFIELD COUNTY: Elm Creek, about 20 mi. NW Glenwood Springs; 12 mi. from [NNE] Rifle, near power plant (P. H. Miller, 1964:94); between Grizzly Creek and Noname Creek; *South Canyon, near Atchee* (P. H. Miller, *loc. cit.*); *3 mi. NW New Castle* (Goldman, 1946: 211); *Book Cliffs, between De Beque and Utah state line* (P. H. Miller, *loc. cit.*); N of Loma (P. H. Miller, *loc. cit.*). GRAND COUNTY: Granby (Goldman, 1946:211). BOULDER COUNTY: near Boulder (Coues, 1879:218). CLEAR CREEK

COUNTY: no precise locality (Trippe, 1874). MESA COUNTY (P. H. Miller, 1964:94, unless otherwise noted): Book Cliffs, N of Fruita; *20 mi. N Mack* (CU catalog, specimen not found); N of Mack; S side of Kimball Creek, near De Beque; near Clifton; near Whitewater; near Gateway (CU catalog, specimen not found). PITKIN COUNTY: *2 1/2 mi. S Basalt;* 3 mi. S Basalt (Goldman, 1946:211). PARK COUNTY: no precise locality (J. A. Allen, 1874:53). DELTA COUNTY: *Coal Gulch* (not found) (P. H. Miller, 1964:94). TELLER COUNTY: E side Pike National Forest (Young, 1946:53); Victor (Young, 1946:90). MONTROSE COUNTY: between Sinbad Valley and Rock Creek; Bedrock (Goldman, 1946:211); Horsefly [Creek] section, W of Montrose (Young, 1946:54). SAGUACHE COUNTY: Rito Alto Creek (Young, 1946:53); Middle Fork, Carnero Creek (Young, 1946:126). FREMONT COUNTY: 12 mi. N Cañon City (Seton, 1929, 1:77); 4 mi. N Echo; *Texas Creek* (Young, 1946:55); 7 mi. SE Cotopaxi (Goldman, 1946:211); Oak Creek Canyon, 12 mi. S Cañon City; Wetmore District, San Isabel National Forest, 30 mi. W Pueblo (Young, 1927:158). ALAMOSA COUNTY: Sangre de Cristo Mountains, S of Mosca Pass (Young, 1946: 55). HUERFANO COUNTY: 15 1/2 mi. NW Gardner (Young, *loc. cit.*); near La Veta (Young, *op. cit.*:115). MONTEZUMA COUNTY: Mesa Verde National Park (Anderson, 1961:61). LA PLATA COUNTY: 18 mi. N Durango (Goldman, 1946:211); Florida (J. A. Allen, 1893:83). ARCHULETA COUNTY: near Pagosa Springs (Young, 1946:74). CONEJOS COUNTY: Conejos River, near Trout Creek Lodge. LAS ANIMAS COUNTY: Abbit [Abbott] Creek, SW of Monument Lake (Young, 1946:53).

For additional observational reports and remarks on local abundance, see Cary (1911:164-165).

Lynx canadensis

Canada Lynx

Lynx canadensis is an inhabitant of the dense boreal forests of North America, occurring over most of the continent north of about 43°, and formerly extending southward in the forests of the higher mountains to south-central Utah and southwestern Colorado. For comments on relationships between the Canada lynx and the Old World lynx, see Rausch (1953) and Kurtén and Rausch (1959).

Some early writers (J. A. Allen, 1874:53; Coues, 1879:218, see remarks beyond) reported the lynx as common in Colorado at some places. By 1900, reports of the species had grown less numerous. Warren (1906:257) observed that reliable information on the status of the lynx was needed, adding that ". . . many, if not most of the reported lynxes are the big mountain bobcat. . . ." Cary (1911: 165-167) listed many reports of lynx. Most of those reports are based on observations by trappers and, while they cannot be dismissed out of hand, ought to be regarded with a degree of caution. I am unaware of specimens taken in recent years. Long (1965:708) reported that a specimen was taken in the winter of 1963 at a place 8 mi. SE of Laramie, Albany Co., Wyoming.

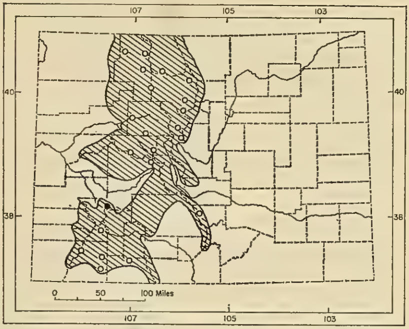


FIG. 110. Distribution of *Lynx canadensis canadensis* in Colorado. For explanation of symbols, see p. 9.

For many years the lynx was designated a predator in Colorado and thus afforded no protection. Hunting regulations for 1970 changed that status with the following statement: "All areas of state *closed* to hunting chipmunk and lynx." Hopefully this protection has not come too late.

Lynx canadensis canadensis Kerr

Lynx canadensis Kerr, The animal kingdom . . . , 1:157, 1792; type locality, Quebec.

[Lynx canadensis] var. *montanus* Coues, *in* Dartt, On the plains and among the peaks . . . , Appendix, p. 218, 1879 (*nomen nudum,* see remarks beyond).

Distribution in Colorado.—Known only from scattered localities at higher elevations in forested mountains of central part of state (Fig. 110).

Measurements.—External measurements of a specimen (sex not designated) from Breckenridge are: 940, 121, 241 (after Warren, 1942:105). Selected cranial measurements of a young adult male (USNM 246372) from 20 mi. S Cimarron, *in* Gunnison County, are: condylobasal length, 117.2; zygomatic breadth, 91.2; interorbital constriction, 29.3; postorbital constriction, 37.6; mastoid breadth, 54.6; length of maxillary toothrow, 39.1.

Remarks.—The brief account of *L. canadensis* by Coues (1879:218) is problematic. Inasmuch as the publication cited is not readily available, I quote the account in full:

> The common Lynx of the Rocky Mountains in this latitude appears to be a modification of the Canada lynx, *L. canadensis* of authors, and is perhaps entitled to varietal designation as a geographic race of that species. It may be named var. *montanus.* I have seen similar specimens from elevated portions of California. These Lynxes do not seem to be specifically separable from *L. canadensis,* but they are distinguishable at a glance from the *Lynx rufus,* which also occurs in the same locality. They are much more abundant than the *L. rufus,* and numbers are shot or trapped each year. Several well-prepared specimens are contained in the [Maxwell] Collection.

Few authors that I have read have regarded *L. canadensis* as more abundant than *L. rufus* in Colorado, particularly in the foothills of the Front Range, the general area of Coues' interest. While Coues noted that specimens are "distinguishable at a glance" from *L. rufus,* he did not indicate how that distinction is made, so that it is impossible to be certain that his concept of *canadensis* is that commonly accepted today. That his concept of *canadensis* is not the usual one is indicated by the statement that he had ". . . seen similar specimens from elevated portions of California." *Lynx canadensis* is not known ever to have occurred in California (see Grinnell *et al.,* 1937:609). Perhaps Coues was distinguishing as "*L. canadensis*" the large, pallid bobcat of the mountains, herein referred to *L. rufus pallescens.* Occasional bobcats from the foothills are reddish in color, and one might imagine that two species occurred there.

The name *montanus* as applied by Coues *(loc. cit.)* to Coloradan lynx is a *nomen nudum,* inasmuch as it is unaccompanied by description, definition, or indication of the taxon to which it was applied. As such, the name has no standing in zoological nomenclature.

Records of occurrence.—Specimens examined, 1, as follows: GUNNISON COUNTY: 20 mi. S Cimarron, 1 (USNM).

Additional records (Cary, 1911:165-167, unless otherwise noted): ROUTT COUNTY: Elkhead Mountains; W slope of Park Range; 2 mi. S Steamboat Springs; Gore Range. JACKSON COUNTY: "*North Park slope of Rabbit Ears Mountains . . .*"; near head of Arapahoe Creek. RIO BLANCO COUNTY: South Fork, White River. GARFIELD COUNTY: Mud Springs, White River Plateau. EAGLE COUNTY: Defiance Trail, below Dotsero (Seton, 1929, 1:190); Mount Jackson. GRAND COUNTY: Grand Lake; Vasquez Mountains; near headwaters of Williams Fork. SUMMIT COUNTY: Breckenridge (Warren, 1942:105). PITKIN COUNTY: Independence Pass; Snowmass Peak. PARK COUNTY: Jefferson (Young, 1958:13); vicinity of Mount Lincoln (J. A. Allen, 1874:53). GUNNISON COUNTY: Italian Mountain; Taylor Park. CUSTER COUNTY: "C. E. Aiken has one in his store from Buelah . . . which was taken either in the Greenhorn or Sangre de Cristo range" (Warren, 1906:258). SAN JUAN COUNTY: San Juan Mountains. LA PLATA COUNTY: La Plata Mountains; Vallecito region; Bayfield, 6500 ft. ARCHULETA COUNTY: mountains N of Pagosa Springs.

Lynx rufus

BOBCAT

The bobcat occurs in suitable habitats throughout the temperate and subtropical parts of North America, from southern British Columbia southward to Veracruz and Oaxaca. In Colorado, greatest numbers occur in the foothills and canyons of the mountainous western three-fifths of the state and in the broken terrain of the area south of the Arkansas River. Elsewhere in eastern Colorado, *Lynx rufus* occurs sparingly, in areas of local relief where cover is suitable. I doubt that the pattern of distribution of bobcats in Colorado has been materially affected by settlement, although over some parts of the range numbers have been reduced.

The natural history of the bobcat was discussed by S. P. Young (1958). That work contains details on the species in Colorado.

Under Colorado law the bobcat is regarded as a "non-game mammal," subject to licensed hunting throughout the year. In 1962, the Branch of Predator and Rodent Control reported taking 1616 bobcats. Nearly all of these were trapped or trailed with dogs and then shot. Because bobcats rarely eat carrion they are less susceptible to poison-sets than are the several kinds of canids. Fur dealers in Colorado reported handling an average of 1598 skins of bobcats over the nine-year period 1959 through 1967 (range, 1066 in 1965 to

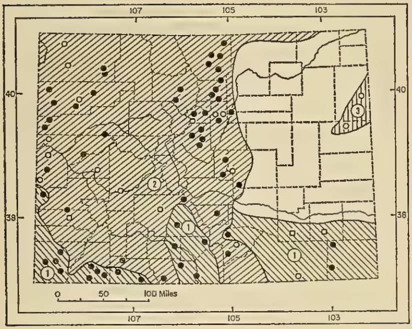


FIG. 111. Distribution of *Lynx rufus* in Colorado. 1. *L. r. baileyi*. 2. *L. r. pallescens*. 3. *L. r. rufus*. For explanation of symbols, see p. 9.

2186 in 1959) (unpublished data from Division of Game, Fish and Parks). The figures reported possibly include an unknown number of lynx.

Lynx rufus baileyi Merriam

Lynx baileyi Merriam, N. Amer. Fauna, 3:79, 11 September 1890; type locality, Moccasin Spring, N of Colorado River, Coconino Co., Arizona.

[Lynx rufa] baileyi, Elliot, Field Columbian Mus., Publ. 45, Zool. Ser., 2:297, 6 March 1901.

Distribution in Colorado.—In suitable habitats at lower elevations in southern part of state (Fig. 111).

Comparison.—From *L. r. pallescens*, the subspecies of central and western Colorado, *L. r. baileyi* differs in somewhat smaller average size both externally and cranially, and typically more buffy to reddish color.

For comparison with *L. r. rufus*, see account of that subspecies.

Measurements.—External measurements of a female from Baca County are: 769, 146, 169. Selected cranial measurements of a male and two females from Baca County are: condylobasal length, 120.7, 100.6, 109.3; zygomatic breadth, 88.7, 83.7, 79.8; interorbital constriction, 26.4, 23.6, 23.2; postorbital constriction, 39.8, 38.0, 37.4; mastoid breadth, 54.6, 51.8, 55.1; length of maxillary toothrow, 41.6, 36.8, 35.0.

Selected cranial measurements of a male and three females from the vicinity of Monte Vista, Rio Grande County, are: condylobasal length, 121.6, 107.0, 105.4, 105.9; zygomatic breadth, 94.7, 82.2, 84.3, 82.8; interorbital constriction, 26.2, 25.8, 23.2, 21.2; postorbital constriction, 40.6, 41.1, 38.0, 39.9; mastoid breadth, 56.2, 51.5, 50.8, 51.6; length of maxillary toothrow, 41.3, 37.0, 35.7, 35.6.

Cranial measurements of two males and two females from southeastern Montezuma County include: condylobasal length, 114.9, 116.4, 106.2, 106.9; zygomatic breadth, 89.9, 90.4, 83.5, 82.0; interorbital constriction, 26.5, 24.3, 23.5, 25.0; postorbital constriction, 38.2, 42.1, 39.3, 42.6; mastoid breadth, 58.0, 54.3, 52.3, 51.2; length of maxillary toothrow, 37.4, 37.4, 35.0, 36.5.

Remarks.—Geographic variation over the range of *L. rufus* is in need of thorough study. In general, two kinds of bobcats occur commonly in Colorado. Specimens from mountainous portions of the state generally are larger than those from elsewhere, and the few available skins suggest that animals there also typically are paler in color, less rufescent and more grayish. Specimens from the extreme southwest, from the San Luis Valley, and from southeastern Colorado tend to be smaller in size, somewhat more richly colored and more distinctly patterned. Color, however, is not a reliable criterion for distinguishing Coloradan bobcats.

The name *L. r. pallescens* apparently applies to the highland populations (see Durrant, 1952:442, for comments on the status of *L. uinta* Merriam). Smaller animals from lower elevations in the southern parts of the state are referred to *L. r. baileyi*.

Cary (1911:167) reported observations from Yuma and Kit Carson counties under the name *baileyi*, but I have seen no specimens from that area. What name ought to apply to bobcats from northeastern Colorado is—in the absence of specimens—a matter for conjecture. Jones (1964:305) tentatively referred all Nebraskan bobcats to *L. r. rufus*. Cockrum (1952:264) referred bobcats from Kansas west of about 98° to *L. r. baileyi*. Long (1965:709) referred all bobcats from Wyoming to *L. r. pallescens*, noting that "many specimens from south-central and southeastern Wyoming are slightly more reddish than specimens from other parts of Wyoming." Also, cranial measurements given by Long (*op. cit.*:708-709) of specimens from the southeast (Laramie and Albany counties) tend to be somewhat smaller than those from farther north (Niobrara and Fremont counties). Perhaps this indicates intergradation with (or clinal change toward) the populations known as *L. r. baileyi* and *L. r. rufus.*

A comparable pattern of variation is to be seen in Colorado, where specimens from the foothills of the Front Range approach the smaller size of the non-montane races. Cary (1911:167) referred specimens from Arkins, Larimer County, to *baileyi.*

In the absence of specimens, records from northeastern Colorado can be allocated only on geographic grounds. I would tentatively suggest that animals from that area probably have more continuity of range to the north and east than to the west and are best referred to *L. r. rufus.*

Records of occurrence.—Specimens examined, 39, distributed as follows: MONTROSE COUNTY: *La Sal Mountains,* 1 (USNM); West Paradox Valley, 1 (DMNH). SAGUACHE COUNTY: Russell Springs, 1 (USNM). RIO GRANDE COUNTY: Monte Vista, 4 (USNM). ALAMOSA COUNTY: 4 mi. S, 1 mi. E Great Sand Dunes National Monument, 2 (KU). HUERFANO COUNTY: 10 mi. E Gardner, 1 (CU). MONTEZUMA COUNTY: Dolores, 7000 ft., 1 (CSU); McElmo, 3 (USNM); McElmo Canyon, 6000 ft., 1 (CSU); Cortez, 1 (CSU); White Canyon, Mesa Verde, 1 (WC); Prater Canyon, 7500 ft., 1 (KU); 2 mi. below Waters Ranch, Mancos Cañon, 6000 ft., 2 (WC). LA PLATA COUNTY: Durango, 1 (USNM); Florida Mesa, 1 (USNM); *Florida River,* 2 (USNM); Beaver Creek, 2 (USNM); Animas River, 1 (USNM). ARCHULETA COUNTY: *Stollsteimer Creek, near mouth of Archuleta Cañon,* 1 (UNM); "Piedra River, Durango," 1 (USNM); Chromo, 1 (DMNH); *Navajo Springs,* 1 (USNM). CONEJOS COUNTY: La Jara, 1 (USNM). COSTILLA COUNTY: Cenicro [Rio Grande, 25 mi. SE La Jara], 1 (USNM). LAS ANIMAS COUNTY: near Emery Gap, Negro Mesa [probably near Long Mesa], 2 (WC). BACA COUNTY: Gaume's Ranch, 1 (WC); Estelene [sec. 16, T. 33 S, R. 50 W], 2 (USNM); *no locality other than county,* 1 (DMNH).

Additional records: OTERO COUNTY: southern part of county (Cary, 1911:167). BENT COUNTY: southern part of county (Cary, *loc. cit.*). MONTEZUMA COUNTY: *Knife Edge Road, Mesa Verde National Park* (Anderson, 1961:61). LAS ANIMAS COUNTY: *Mesa de Maya* (Warren, 1942:107).

Lynx rufus pallescens Merriam

Lynx fasciatus pallescens Merriam, N. Amer. Fauna, 16:104, 28 October 1899; type locality, S side of Mount Adams, near Trout Lake, Skamania Co., Washington (Klickitat County, *fide* Dalquest, 1948: 243).

[Lynx rufa] pallescens, Elliot, Field Columbian Mus., Publ. 45, Zool. Ser., 2:297, 6 March 1901.

Distribution in Colorado.—At moderate elevations in mountains of western three-fifths of state (Fig. 111).

Comparisons.—For comparison with *L. r. baileyi* and *L. r. rufus,* see accounts of those subspecies.

Measurements.—External measurements of a male from near Crawford, Delta County, are: 928, 152, 187. Mean (and extreme) cranial measurements of four males and measurements of two females, all from eastern Rio Blanco and Garfield counties, include: condylobasal length, 122.32 (120.1-126.3), 114.1, 115.5; zygomatic breadth, 94.37 (91.2-97.4), 89.7, 89.9; interorbital constriction, 27.12, (25.4-28.0), 26.4, 25.2; postorbital constriction, 39.15 (38.2-39.6), 40.8, 40.8; mastoid breadth, 57.58 (57.1-57.8), 54.8, 57.5; length of maxillary toothrow, 40.78 (38.3-41.8), 38.7, 39.2. Cranial measurements are of specimens obtained by Theodore Roosevelt in 1901 and 1905. No designation of sex was made on the specimens and I have sexed the skulls on the basis of size.

Remarks.—Specimens from Grand County, Utah, north of the Colorado River, were considered by Durrant (1952:443) to be intergrades between *L. r. baileyi* and *L. r. pallescens,* but referable to the former subspecies. Durrant and Robinson (1962:257) regarded specimens from western Gunnison County as intergrades between *baileyi* and *pallescens.* P. H. Miller (1964:97) made a similar appraisal of material from western Mesa County. In fact, intergradation is apparent over wide areas of southwestern and west-central Colorado at moderate elevations. Specimens from Unaweep Canyon, Coventry, and Dolores are, in my judgment, intergrades between *baileyi* and *pallescens.*

Records of occurrence.—Specimens examined, 71, distributed as follows: MOFFAT COUNTY: Iles Mountain, [SW of Craig], 2 (USNM); Hamilton, 1 (USNM). LARIMER COUNTY: 20 mi. N Fort Collins, 1 (CSU); 16 mi. NW Fort Collins, 1 (CSU); *4 mi. N Ted's Place,* 1 (CU); 5 mi. NW Fort Collins, 1 (CSU); sec. 14, T. 7 N, R. 72 W, 1 (CSU); Arkins, 4 (USNM); SW of Berthoud, 1 (CU). RIO BLANCO COUNTY: Rangely, 2 (UMMZ); Meeker, 6 (USNM);

Douglas Creek, 1 (USNM); Piceance, 4 (USNM); *Piceance Creek, 6200 ft.,* 1 (AMNH). GARFIELD COUNTY: Douglas Pass, 1 (CSU); 14 mi. N, 5 mi. W Mack, 5600 ft., 1 (KU); *Salt Creek,* 2 (USNM); Divide Creek, 20 mi. S New Castle, 3 (USNM); *no locality other than county,* 2 (USNM). GRAND COUNTY: Hot Sulphur Springs, 1 (WC); Battle Creek, 1 (USNM). BOULDER COUNTY: NW of Gold Hill, 1 (CU); Boulder Canyon, 1 (CU); 1 mi. N Eldorado Springs, 1 (CU). CLEAR CREEK COUNTY: near Idaho Springs, 1 (DMNH); Georgetown, 1 (AMNH). JEFFERSON COUNTY: Evergreen, 1 (CU). DENVER COUNTY: Denver, 1 (USNM). MESA COUNTY: Grand Mesa, 1 (USNM); Unaweep Canyon, 1 (USNM). PARK COUNTY: Shawnee, 3 (USNM); Jefferson, 1 (USNM); Lost Park, 20 mi. E[SE] Jefferson, 1 (DMNH); Puma Hills, 2 (USNM); South Park, 3 (DMNH). TELLER COUNTY: Woodland Park, 1 (WC); Cripple Creek, 1 (KU). EL PASO COUNTY: 20 mi. S Colorado Springs, 1 (WC). MONTROSE COUNTY: Coventry, 6 (5 USNM, 1 WC). SAGUACHE COUNTY: about 3 mi. E Villa Grove, 1 (ASC). CUSTER COUNTY: Junkins Park, 14 mi. E Westcliffe, 1 (SCSC). HUERFANO COUNTY: 2 mi. W La Veta, 1 (CU). ARCHULETA COUNTY: Gordon Creek, near junction with Piedra River, 1 (UNM). CONEJOS COUNTY: Conejos River, 22 mi. W Antonito, 1 (ASC).

Additional records (Cary, 1911:168 unless otherwise noted): MOFFAT COUNTY: W of [Little] Snake River, between Bagg's Crossing and Escalante; 1 mi. N Lily. RIO BLANCO COUNTY: Little Hills Experiment Station, W of Meeker (Young, 1958:35); *Little Alkali Creek, near Housetop Mountain* (not found) (Young, 1928:64). CLEAR CREEK COUNTY: Mount McClellan, 10,500 ft. (Young, 1958:13). JEFFERSON COUNTY: a few miles SW of Golden, 7300 ft. (Young, *loc. cit.*). PARK COUNTY: Mount Lincoln (Blake and Blake, 1969:37). DELTA COUNTY: Rogers Mesa, near Lazear. GUNNISON COUNTY (Durrant and Robinson, 1962:257): *Red Creek, near junction with Gunnison River, 7800 ft.;* U.S. Highway 50 at North Willow Creek, 7550 ft. TELLER COUNTY: *Gillet* (Warren, 1906:258). EL PASO COUNTY: *Ruxton Park* (Warren, 1942: 109); Crystal Park (Warren, 1906:258). SAN MIGUEL COUNTY: no precise locality (Warren, *loc. cit.*). SAGUACHE COUNTY: 10 mi. NW Saguache (Young, 1958:102). CUSTER COUNTY: no precise locality. HUERFANO COUNTY: Walsenburg (Young, 1958:17).

Lynx rufus rufus (Schreber)

Felis rufa Schreber, Die Säugthiere . . . , 3: pl. 109b, 1777; type locality, New York.

Lynx rufus, Rafinesque, Amer. Monthly Mag., 2:46, November 1817.

Distribution in Colorado.—Of suspected occurrence locally in northeastern part of state (see Fig. 111 and remarks beyond).

Comparisons.—From *L. r. baileyi,* the subspecies of southern Colorado, *L. r. rufus* differs in somewhat larger external and cranial size and darker, more conspicuously patterned pelage. From *L. r. pallescens,* the subspecies of central and western Colorado, *L. r. rufus* differs in slightly smaller size and darker, more reddish and less grayish, color.

Remarks.—I have examined no specimens from northeastern Colorado, and records of bobcats from that area are referred to *L. r. rufus* solely on geographic grounds. For brief comments on geographic variation in Coloradan bobcats, see the account of *L. r. baileyi,* above.

Records of occurrence.—Specimens examined, none.

Additional records (Cary, 1911:167): YUMA COUNTY: along Chief Creek, near Wray. KIT CARSON COUNTY: South Fork Republican River, near Tuttle.

Order ARTIODACTYLA

Aside from domestic animals, eight species of Recent artiodactyls occur in Colorado. Of that number, one is introduced (*Oreamnos americanus*), one is of only occasional occurrence (*Alces alces*), and a third (*Bison bison*) has been re-introduced after extirpation from the state. The white-tailed deer also was extirpated in Colorado, but has re-invaded the state naturally.

All Coloradan artiodactyls except moose are subject to licensed hunting and are carefully managed by the Division of Game, Fish and Parks. An extensive program of research on big game animals is conducted by that agency. No attempt is made to cite the resulting technical literature in detail. The interested reader is directed to the resumé by Tileston and Yeager (1962) of research projects. Hay *et al.* (1961) discussed Coloradan game management in general terms. Feltner (1962) presented an excellent history of the Game and Fish Department up to 1961, including considerable data of mammalogical interest. Additional sources of information include the *Colorado Game Research Review, Quarterly Reports* of the Colorado Cooperative Wildlife Research Unit (Colorado State University), *Technical Bulletins* of the Division of Game, Fish and

Parks, *Special Reports* of the Game Research Section and annual reports of big game harvest. Semitechnical and popular publications include a series of information leaflets and the bi-monthly magazine, *Colorado Outdoors*, successor to *Colorado Conservation Comments.*

Because of their size and frequent value as trophies, skins and skulls of artiodactyls seldom are adequately represented in collections of scientific specimens. The few specimens available do not reflect adequately the historical or modern ranges of the species in question. Range maps used herein were drafted on the basis of data from the Division of Game, Fish and Parks, and I have attempted to reconstruct former ranges of species based on historical and zoological literature. No attempt was made to make exhaustive lists of additional records. Citations included are from important faunal works, works of historical interest, or published notes on the biology of a given species in Colorado.

A further departure from the format established previously for accounts of species is that measurements are not included. Available data are meager and do not depict adequately a range of variation. Furthermore, because of extensive programs of transplanting and the disturbance of migrational patterns, some measurements might be misleading, reflecting only grossly—if at all—patterns of variation prior to massive human disturbance.

Key to Species of Artiodactyla in Colorado

1. Frontal appendages of horn covering a bony core 2
   Frontal appendages branched antlers 5

2. Horns branched .... *Antilocapra americana*
   Horns unbranched 3

3. Horns smooth, without annular ridges, curving anterolaterally .... *Bison bison*
   Horns, rough, with annular ridges 4

4. Horns (of males) robust, curving in posterolateral helix; lacrimal pits present .... *Ovis canadensis*
   Horns of moderate size, only slightly curved posterolaterally; lacrimal pits absent .... *Oreamnos americanus*

5. Antlers palmate, nasals relatively short .... *Alces alces*
   Antlers not palmate; nasals relatively long 6

6. Antlers with prominent brow tine; upper canine present .... *Cervus canadensis*
   Antlers without prominent brow tine; upper canine absent 7

7. Tail narrow, white with black terminal tuft; antlers branched dichotomously, anterior and posterior beams nearly equal; metatarsal glands large, more than 100 mm long .... *Odocoileus hemionus*
   Tail broad, brown above, white beneath; anterior beam of antler longer; metatarsal glands small, about 25 mm long .... *Odocoileus virginianus*

Family Cervidae—Deer and Allies

Cervus canadensis

American Elk

Prior to the advent of European civilization in North America, the elk, or wapiti, was widespread across the central and northern United States and extended northward along the Canadian Rockies and adjacent plains. In Colorado, elk apparently always have been more abundant in the western mountainous parts of the state, but Warren (1906: 277) noted that the species once occurred sparingly on the plains as well. Specific records from the eastern one-third of the state are lacking. The elk occurs in parks, meadows, alpine tundra, and in areas of open forest.

Elk were abundant in Colorado in the mid-1800's, but populations of the large gregarious mammals were decimated by market-hunting. J. A. Allen (1874:56) noted that elk in South Park were becoming rare in 1871. By 1910 an estimated 500 to 1000 elk remained in Colorado, mostly along the upper White River. Hunting of elk was closed from 1913 to 1929. Beginning in 1912, 14 introductions of animals from Wyoming were made over a 16-year period, totalling 350 elk (see Culbreath, 1947). For a resumé of the successful re-establishment of *Cervus canadensis* in Colorado, see Swift (1945).

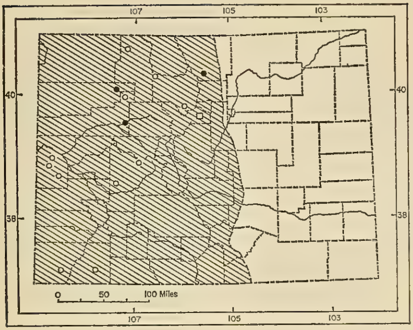


FIG. 112. Distribution of *Cervus canadensis nelsoni* in Colorado. Approximate modern distribution shaded; historic distribution perhaps statewide in suitable habitat. For explanation of symbols, see p. 9.

Transplanting has led to an apparent extension of range in western Colorado. Elk were introduced at Colorado National Monument in 1924 from the Denver Mountain Parks. Animals now winter there, in Glade Park, and on Piñon Mesa. P. H. Miller (1964: 100) learned from long-time residents of the area that elk had not occurred northwest of Unaweep Canyon prior to their introduction into the National Monument.

Re-establishment of elk in Rocky Mountain National Park allowed study of the effects of increasing numbers on the habitat. Wright *et al.* (1933) discussed the status of elk in the park. Re-establishment was made difficult because during the period that elk were rare or absent in the area patterns of land-use changed and the winter range of the elk was separated from the summer range by settlement and fencing. Serious shortages of winter forage resulted, and damage by elk befell ranchers in the vicinity. The situation was relieved to some extent by the addition of parts of Moraine Park, Horseshoe Park, and Beaver Meadows to Rocky Mountain National Park. Today, those areas are excellent places to observe elk in large numbers in winter. Packard (1947a) discussed deer and elk in Rocky Mountain National Park in detail (also see Cahalane, 1948:254).

In 1969, 20,850 elk were harvested in Colorado. The five leading counties in the 1969 elk harvest were Rio Blanco, Routt, Gunnison, Archuleta, and La Plata (Colorado Big Game Harvest, 1969: *passim*). Management of Coloradan elk is by a system comparable to that used for deer. Seasons, numbers of permits issued, and restrictions on sex and age of lawful game are based on local conditions and vary widely over the state.

It is possible that the wapiti is conspecific with the Eurasian red deer, *Cervus elaphus* (see McCullough, 1969). However, in the absence of definitive study of the problem, I retain the use of the name *Cervus canadensis* for the North American population.

Cervus canadensis nelsoni Bailey

Cervus canadensis nelsoni Bailey, Proc. Biol. Soc. Washington, 48:188, 15 November 1935; type locality, Yellowstone National Park, Wyoming.

Distribution in Colorado.—Mountainous western three-fifths of state; formerly to an unknown extent on plains of eastern Colorado (Fig. 112).

Remarks.—As pointed out by Murie (1951:15), *C. c. nelsoni* has not been diagnosed adequately. Specimens of elk from eastern North America, the range of nominotypical *canadensis*, are not available for comparison. Separation of western elk as a distinct subspecies was predicated on the not wholly unreasonable assumption that elk of the Rocky Mountains probably differed from those of eastern North America. In the absence of adequate distinction between nominal subspecies, however, use of the name *nelsoni* for Coloradan elk is tentative, following Murie (*loc. cit.*).

Records of occurrence.—Specimens examined, 6, distributed as follows: LARIMER COUNTY: *Little Horseshoe Park, 8500 ft.*, 1 (KU); Moraine Park, 8000 ft., 3 (KU). RIO BLANCO COUNTY: Pagoda Peak, 1 (KU). GARFIELD COUNTY: Jules Basin, near Glenwood Springs, 1 (FMNH).

Additional records: ROUTT COUNTY: Sand Peak [T. 9 N, R. 86 W] (Felger, 1910:142). LARIMER COUNTY: *Rocky Mountain National Park* (Kingman and Yeager, 1951:112; Herin, 1968:762). GRAND COUNTY: 3 mi. SW Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53); Williams Fork drainage, Arapahoe National Forest (Gilbert and Hill, 1955:129). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:224). MESA COUNTY (introduced animals—P. H. Miller, 1964:100): Rim Rock Drive, head of Ute Canyon; *South Rim, Ute*

Canyon; Glade Park; Piñon Mesa. PARK COUNTY: *Mount Lincoln* (Blake and Blake, 1969:37). GUNUNISON COUNTY: north side East Maroon Pass, 10,500 ft. (Findley and Negus, 1953:239); head of Red Creek, 9000 ft. (Durrant and Robinson, 1962: 257). MONTEZUMA COUNTY: Mesa Verde National Park (Anderson, 1961:63). LA PLATA COUNTY: vicinity of Florida (Allen, 1893:70).

Odocoileus hemionus

Mule Deer

The mule deer ranges throughout western North America, from British Columbia southward to northern Mexico. In Colorado the species is statewide in distribution, wherever suitable habitat of forest-edge, woodland, or brush exists. Highest populations occur in the foothills and mountains of the western three-fifths of the state. In summer, individuals in the mountains may range to above timberline, but with the first snows, they descend to protected areas at lower elevations. On the plains, mule deer tend to be localized and generally sedentary.

Early in the present century, populations of *Odocoileus hemionus* on the Eastern Slope had been greatly reduced by the pressure of unrestricted hunting. Cary (1911:56), for example, reported having heard of no mule deer in the foothills of Larimer and Boulder counties in 1906.

Because of the economic importance of deer hunting in Colorado, an impressive volume of literature has accumulated on the biology of *O. hemionus* in the state. A resumé of big game research over the years 1939 through 1957 was prepared by Tileston and Yeager (1962). Dorrance (1966) provided an annotated bibliography on behavior of mule deer, and Tolman (1949) discussed population dynamics of deer near Gunnison. Loveless (1967) reported on an excellent ecological study of mule deer on winter range on Sevenmile Creek, Larimer County. For a review of the biology of *O. hemionus* over its range, see W. P. Taylor (1956).

Deer are a renewable resource subject to careful management in Colorado. Seasons and limits vary over the state, and a complex management plan maintains populations for sustained high yield. In 1969, 176,114 licenses were sold and 87,362 deer were harvested. Deer hunters spent an estimated 41 million dollars pursuing their sport (Colorado Big Game Harvest, 1969: *passim*). The five counties with the highest deer harvest in 1969 were Garfield, Rio Blanco, Eagle, Montrose and Gunnison, and the top ten counties all were on the Western Slope.

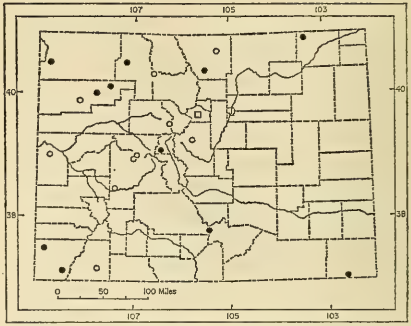


FIG. 113. Distribution of *Odocoileus hemionus hemionus* in Colorado. For explanation of symbols, see p. 9.

Odocoileus hemionus hemionus (Rafinesque)

Cervus hemionus Rafinesque, Amer. Monthly Mag., 1:436, October 1817; type locality, mouth of Big Sioux River, Union Co., South Dakota.

Odocoileus hemionus, Merriam, Proc. Biol. Soc. Washington, 12:100, 30 April 1898.

Distribution in Colorado.—Statewide in suitable habitats (Fig. 113).

Records of occurrence.—Specimens examined, 20, distributed as follows: MOFFAT COUNTY: Pot Creek, 3 (USNM). ROUTT COUNTY: S of Hayden, 3 (USNM). LARIMER COUNTY: Estes Park, 1 (KU); *4 1/2 mi. SW Estes Park,* 2 (KU). LOGAN COUNTY: 2 mi. S, 12 mi. W Peetz, 1 (KU). RIO BLANCO COUNTY: Lost Peak, 1 (USNM); Meeker, 1 (USNM). LAKE COUNTY: Twin Lakes, 2 (USNM). ALAMOSA COUNTY: Mosca Pass, 3/4 mi. NE Headquarters, Great Sand Dunes National Monument, 2 (KU). MONTEZUMA COUNTY: Ackmen, 1 (FMNH); Far View Ruins, Mesa Verde National Park, 1 (KU); *Spruce Tree House,* 1 (KU). BACA COUNTY: Regnier, 1 (USNM).

Additional records: LARIMER COUNTY: *Cache la Poudre drainage* (Rees *et al.,* 1966:640); sec. 25, T. 8 N, R. 71 W, about 7200 ft. (Short and Short, 1964:315). RIO BLANCO COUNTY: Little Hills Experiment Station (Short, 1964:319). EAGLE COUNTY: just W of Vail Pass (Hunter and Kinghorn, 1950:193). GRAND COUNTY: 3 mi. SW

Rabbit Ears Pass, 9900 ft. (Vaughan, 1969:53). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874:224). MESA COUNTY (P. H. Miller, 1964:102): 1/4 mi. W Utility Area, Colorado National Monument, 5800 ft.; *1 mi. E Glade Park Road on Rim Rock Drive, 6415 ft.* PARK COUNTY: South Park (J. A. Allen, 1874:56); *Mount Lincoln* (Blake and Blake, 1969:37). GUNNISON COUNTY: timberline near Copper Lake (Findley and Negus, 1953:239); vicinity of Gothic (Findley and Negus, *loc. cit.*); Gunnison River (Coues and Yarrow, 1875:71); *Dry Gulch, 1 1/2 mi. N Gunnison River, 8300 ft.* (Durrant and Robinson, 1962:258); *mesa NW of Dry Gulch, 8300 ft.* (Durrant and Robinson, *loc. cit.*); Dry Gulch, 1 mi. N Gunnison River, 7550 ft. (Durrant and Robinson, *loc. cit.*). LA PLATA COUNTY: Florida (J. A. Allen, 1893:70).

Odocoileus virginianus

White-tailed Deer

White-tailed deer occur from southern Canada to northern South America and from coast to coast in the United States except for the Great Basin and adjacent canyonlands and deserts, and most of California. The status of the population of white-tailed deer in Colorado is uncertain. White-tails in the state occupy mesic riparian communities.

In the early days of exploration, white-tailed deer evidently occurred in the Arkansas Valley. Arriving at the foot of Pikes Peak in 1806, having followed the Arkansas River across what is now southeastern Colorado, Pike noted in his journal that the party "killed a deer of a new species" (Jackson, 1966:350)—apparently *Odocoileus hemionus.* A deer, presumably *Odocoileus virginianus,* was shot by members of the expedition in the vicinity of the present-day town of Avondale, east of Pueblo (*op. cit.*:349; also see Beidleman, 1957).

Early in the present century, *O. virginianus* occurred in the lower Arkansas Valley, in the Greenhorn Mountain country near Rye, and in the vicinity of Fisher Peak, near Trinidad. The animals of the lower Arkansas Valley increased from five individuals introduced from Wisconsin in 1880 by J. W. Prowers, and flourished until about 1917. They disappeared with the flood of 1921 (Anonymous, 1948).

White-tailed deer were taken first in the Wet Mountains in 1913, but there was no reported kill in that area from 1916 to 1948. These animals, and those on Fisher Peak, were thought to be migrants from New Mexico (Anonymous, 1948). Cary (1911:55) reviewed the early history of the white-tailed deer in northeastern Colorado. Early reports never considered the species to be abundant in that part of the state (see, for example, Coues, 1879:222).

In the 1950's, reports began to be made of white-tailed deer in the South Platte Valley. In 1964, 42 white-tails from Oklahoma were released at Weldona, Morgan County, and Cherokee Park, northwest of Fort Collins (Anonymous, 1965). Until 1969, total harvest of white-tailed deer in Colorado was unknown. In that year, report cards filed by hunters in a special-permit season in the northeastern part of the state differentiated between mule deer and white-tails. In the area involved (roughly the South Platte drainage east of the foothills), 63 white-tails were taken, 11 per cent of the total harvest. In some management units immediately adjacent to the South Platte River, white-tailed deer comprised more than 20 per cent of the harvest (Colorado Big Game Harvest, 1969:25).

The natural history of *O. virginianus* was summarized in detail in *The Deer of North America* (W. P. Taylor, ed., 1956). Kellogg (*in* Taylor, *op. cit.*:37-55) reviewed the subspecies of *O. virginianus.* Two subspecies, as noted below, were ascribed ranges in Colorado.

Odocoileus virginianus dacotensis Goldman and Kellogg

Odocoileus virginianus dacotensis Goldman and Kellogg, Proc. Biol. Soc. Washington, 53:82, 28 June 1940; type locality, White Earth River, Mountrail Co., North Dakota.

Distribution in Colorado.—To an undetermined extent along South Platte and Republican rivers in northeastern part of state and north of Roan Plateau in the northwest (Fig. 114).

Comparison.—From *O. v. texanus*, the subspecies adjacent to the south, *O. v. dacotensis* differs in brighter (more reddish and less grayish) color, larger size, more massive skull, heavier cheekteeth, and more robust antlers (after Kellogg, *in* Taylor, 1956:43).

Remarks.—In the absence of any taxo-

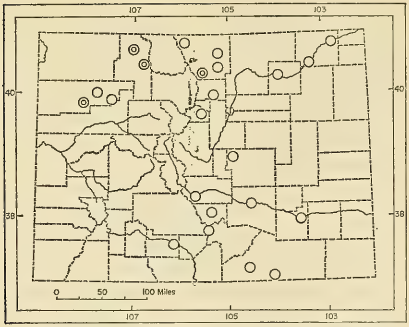


FIG. 114. Distribution of two species of Cervidae in Colorado. Single circles, *Odocoileus virginianus*; concentric circles, *Alces alces*. For explanation of symbols, see p. 9.

nomic revision of *O. virginianus* over its range, I tentatively follow the arrangement of subspecies reviewed by Kellogg (*in* Taylor, 1956). Jones (1964:318) referred Nebraskan whitetails to the subspecies *O. v. macrourus*. Natural populations in northeastern Colorado doubtless are derived from the population in southwestern Nebraska, and certainly no zoogeographic importance is ascribed to nominal differences between subspecies in the two areas. Animals introduced to the South Platte Valley and Cache la Poudre drainage from Oklahoma perhaps represent the subspecies *O. v. texanus*.

Records of occurrence.—Specimens examined, none.

Additional records (Cary, 1911:55, unless otherwise noted): LARIMER COUNTY: Laramie River region; Cache la Poudre Creek (Coues, 1879:222); sec. 9, T. 7 N, R. 69 W (Harrington, 1959:251); W of Arkins. MORGAN COUNTY: Weldona (Anonymous, 1965:5). LOGAN COUNTY: near Crook (Harrington, 1959:251); 1/2 mi. S Merino (Till, 1954:269). RIO BLANCO COUNTY: Josephine Basin, about 4 mi. W Meeker (Lechleitner, 1969:219); Marvine Lodge (Felger, 1910:142). BOULDER COUNTY: 5 mi. W Boulder. CLEAR CREEK COUNTY: near summit of Floyd Hill; *no precise locality* (Trippe, 1874:224).

Odocoileus virginianus texanus (Mearns)

Dorcelaphus texanus Mearns, Proc. Biol. Soc. Washington, 12:23, 27 January 1898; type locality, Fort Clark, Kinney Co., Texas.

Odocoileus virginianus texanus, Lydekker, Catalogue of the ungulate mammals in the . . . British Museum, 4:158, 1915.

Distribution in Colorado.—Southeastern part of state and formerly in San Luis Valley (Fig. 114).

Comparison.—For comparison with *O. v. dacotensis*, see account of that subspecies.

Remarks.—Probably animals from Oklahoma introduced at Weldona and Cherokee Park in December 1964 were of this subspecies. In addition, native stocks in the southeastern part of the state would be expected to represent *O. v. texanus*. In view of the lack of adequate material, no attempt is made to demarcate limits of subspecies in figure 114.

Records of occurrence.—Specimens examined, none.

Additional records (Cary, 1911:55, unless otherwise noted): EL PASO COUNTY: foothills W of Monument (Warren, 1906:237). SAGUACHE COUNTY: vicinity of Mosca and Medano passes. CUSTER COUNTY: Wet Mountains, E of Westcliffe. FREMONT COUNTY: Cottonwood Creek, near Cotopaxi (Warren, 1942:284). PUEBLO COUNTY: Arkansas Valley, between Pueblo and state line (Warren, 1906:237). RIO GRANDE COUNTY: San Luis Valley (Coues and Yarrow, 1875:72). LAS ANIMAS COUNTY: near Trinidad and southward (Warren, 1006:237); near Watervale (Warren, 1942:284).

Alces alces

MOOSE

Moose occur in Colorado only as occasional wandering individuals in the north-central part of the state, and there is no evidence to indicate that the species ever has been represented by a breeding population there. The well-known tendency of *Alces alces* to move with elk or even domestic cattle may be responsible for the presence of the species in Colorado. Peterson (1955) discussed the natural history and taxonomy of the species.

Alces alces shirasi Nelson

Alces americanus shirasi Nelson, Proc. Biol. Soc. Washington, 27:72, 25 April 1914; type locality, Snake River, 4 mi. S Yellowstone National Park, Teton Co., Wyoming.

Alces alces shirasi, Peterson, Contrib. Royal Ontario Mus. Zool. and Palaeo., 34:23, 15 October 1952.

Distribution in Colorado.—Known only as scattered individuals in north-central part of state (Fig. 114).

Remarks.—For a critical review of early reports of moose in Colorado, see Warren (1942:286-288).

Records of occurrence.—Specimens examined, none.

Additional records: ROUTT COUNTY: Mica Basin [E of Hahn's Peak P. O.] (A. M. Bailey, 1944: 192); head of Burgess Creek, about 5 mi. E Steamboat Springs (J. C. Miller, 1942:12). LARIMER COUNTY: Estes Park (A. M. Bailey, 1940:96). RIO BLANCO COUNTY: Middle Fork Stuart Creek, 40 mi. SW Meeker (Andrews, 1965:15).

FAMILY ANTILOCAPRIDAE—PRONGHORN

Antilocapra americana

PRONGHORN

The pronghorn originally ranged over much of western North America, in open regions such as the Great Plains, the Great Basin, the Columbia Plateau, and interior valleys of California. *Antilocapra americana* is the sole living representative of a family autochthonous in the North American grassland. The original range in Colorado was statewide in suitable habitats, including areas of short-grass prairie, open shrublands, and mountain parks, at elevations to over 10,000 feet.

Pronghorn were abundant in Colorado in the mid-Nineteenth Century (see G. B. Grinnell, 1929; Cary, 1911:58; Warren, 1942:290). Seemingly boundless herds were greatly reduced by market-hunters. Closed seasons were established in 1885, and market-hunting was outlawed in 1893. From 1899 until 1944 there was no open season on pronghorn. Populations continued to decline for a time, however, because enforcement was inadequate and in 1918 fewer than 1000 pronghorn were thought to exist in Colorado. In 1921 the Colorado Antelope Refuge was established near Norfolk in northeastern Larimer County. Additional refuges were established in eastern Colorado in 1937 and 1941. Antelope restoration over parts of the former range, aided by an extensive program of transplants, began in 1939 (Hoover *et al.*, 1959).

For comments on the status of the pronghorn before recovery was underway, see Skinner (1922). Nelson (1925:27) detailed the distribution of pronghorn in Colorado as of October 1923. Twenty-eight localities over the state reported a total of 1233 pronghorn at that time. An excellent study of the pronghorn in Colorado was reported by Hoover *et al.* (1959). Studies of behavior of *A. americana* in Colorado include papers by Prenslow *et al.* (1968) and Waring (1969).

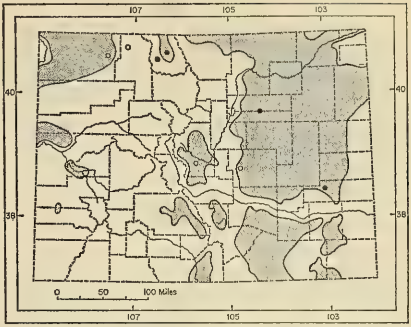


FIG. 115. Distribution of *Antilocapra americana americana* in Colorado. Stippled area, range about 1960; historic range essentially statewide in suitable habitat (data from Division of Game, Fish and Parks). For explanation of symbols, see p. 9.

Open seasons on pronghorns were established in 1945, 1946, and annually since 1949. In 1969, 5222 animals were harvested.

Antilocapra americana americana (Ord)

Antilope americana Ord, *in* Guthrie, A new geographical, historical, and commercial grammar . . . , ed. 2, Philadelphia, 2:292, 1815; type locality, "on the plains and high-lands of the Missouri."

Antilocapra americana, Ord, Jour. Phys. Chim. Hist. Nat. et Arts, 87:149, 1818.

Distribution in Colorado.—Formerly statewide in suitable habitats; presently occurring locally on eastern plains, in mountain parks and San Luis Valley, and in northwestern and west-central parts of state (Fig. 115).

Records of occurrence.—Specimens examined, 5, distributed as follows: ROUTT COUNTY: no locality other than county, 1 (KU). JACKSON COUNTY: North Park, 1 (USNM); Park Range, 1 (USNM). ARAPAHOE COUNTY: 1 mi. E Bennett, 1 (KU). KIOWA COUNTY: Galatea, 1 (USNM).

Additional records: MOFFAT COUNTY: flats N of Craig (Felger, 1910:143). ROUTT COUNTY: California Park [T. 9 N, R. 87 W] (Felger, *loc. cit.*). JACKSON COUNTY: *North Park* (Coues, 1879: 222). PARK COUNTY: South Park (Allen, 1874:56; Coues and Yarrow, 1875:69); S end of South Park (Spencer, 1942:92). EL PASO COUNTY: Jimmy Camp Creek, E of Colorado Springs (Ogilvie, 1955: 146).

FAMILY BOVIDAE—BOVIDS

Bison bison

BISON

The bison once ranged over much of North America, from the Gulf of Mexico northward perhaps to Alaska, and from the Middle Atlantic states to the Columbia Plateau. The center of abundance of the species was on the Great Plains. Bison are known to have occurred over much of Colorado except the southwestern part of the state. Herds of bison on the plains prior to settlement were immense, sufficiently large and awe-inspiring that objective estimates of former populations are virtually impossible. For an extensive historical review of the bison and its importance in the cultural evolution of North America, see Roe (1970). Probably the most useful contemporary account of the decimation of the bison is that by J. A. Allen (1877).

As late as the 1840's, bison ranged in numbers throughout eastern Colorado. Settlement along the mountain front generally drove the major herds eastward. By 1875, the western boundary of the campestrian population was some 100 miles east of the mountains (J. A. Allen, 1877:534). The construction of the transcontinental railroad in the late 1860's split the range of the bison and upset former migratory patterns. The last sanctuaries of plains bison in Colorado were about the headwaters of the Republican, Smoky Hill, and Cimarron rivers. The last known native bison in eastern Colorado was killed near Springfield, Baca County, in 1889 (Warren, 1906:239).

In the mountains, bison occurred in parks and valleys, and apparently ranged above timberline frequently (see Warren, 1927a; Fryxell, 1926, 1928; Beidleman, 1955). Mountain bison were abundant until the influx of miners in the late 1850's. Brewer (1871:221) noted having heard of no bison in South Park in 1869. J. A. Allen (1874:55) reported a few bison from the southern end of South Park in 1871, and Coues and Yarrow (1875:67) mentioned them there in 1873. Coues (1879:221) wrote that bison were taken in Middle Park in 1873 and were present in North Park in 1879. Bergtold (1929) documented the range of the bison on the Western Slope, southward to the White River and Roan plateaus. The last bison known to have been taken in northwestern Colorado was killed by Utes at Cedar Springs, west of Craig, in 1884 (Felger, 1910: 143).

The last surviving wild bison in Colorado were killed in Park County in 1897. According to Cory (1912:89): "In 1888 I saw in Denver, Colorado, eight fresh skins which it was said were killed in a region called Lost Park, in Park County, and the owner claimed that there were several more Buffalo there at that time, which had not been killed. This proved to be the case and it is claimed that in 1890 the herd numbered some twenty individuals. They were gradually killed off until the winter of 1896-97 there were but four left. . . . Mr. T. J. Holland, State Game and Fish Commissioner for Colorado, informs me that these were all killed in Lost Park in February, 1897." Warren (1906:239) presented some rather insubstantial evidence to indicate that bison survived in Lost Park as late as 1904, but that apparently was never confirmed. For further comment on the demise of the mountain bison, see J. A. Allen (1900).

Today, re-introduced bison occur in protected bands at a number of state parks and wildlife areas, all within the former natural range of the species. Bison also have been introduced in Colorado National Monument, Mesa County, where the species apparently is not indigenous (see P. H. Miller, 1962). Bison are raised commercially on a small scale in Colorado. Herds on public lands are maintained carefully, and in 1967 selective hunting of surplus animals in the public herds was licensed, the first open season on bison since 1887. Twenty-two permits were issued in 1969, and 22 animals were harvested.

A thorough taxonomic treatment of Recent bison is not available, and perhaps extant material is inadequate to allow such a study. Accounts of nominal subspecies beyond tentatively follow Skinner and Kaisen (1947).

Bison bison athabascae Rhoads

Bison bison athabascae Rhoads, Proc. Acad. Nat. Sci. Philadelphia, 49:498, 18 January 1898; type locality, within 50 mi. SW of Fort Resolution, District of Mackenzie, Northwest Territories.

Bison bison haningtoni Figgins, Proc. Colorado Mus. Nat. Hist., 12:30, 5 December 1933; type locality, head of Rock Creek, Park Co., Colorado (regarded as inseparable from *B. b. athabascae* by Skinner and Kaisen, 1947:149).

Distribution in Colorado.—Formerly throughout mountains and high plateaus of central and northwestern parts of state (not mapped).

Comparison.—From *B. b. bison*, the subspecies of the Great Plains, *B. b. athabascae* differs in larger skull, broader cranium, and larger, more robust horn cores (after Skinner and Kaisen, 1947:165; see remarks beyond).

Remarks.—Infraspecific taxonomy of *B. bison* has been a matter of some debate. J. A. Allen (1874:55) noted that "the buffalo of the Parks and mountain valleys is said to differ from the buffalo of the plains, and is generally distinguished as the 'Bison,' or 'Mountain Bison.' Although this opinion is widely entertained, the reports respecting the differences that distinguish the two varieties are extremely varied. . . . The alleged differences varied with almost every individual . . . consulted. The mountain buffalo is, however, generally regarded as smaller than the buffalo of the plains, slenderer behind, but provided with a larger hump, and with darker, finer and more abundant wool. I found, however, that the skulls met with in South Park, and in the valley of the South Platte above Fairplay, averaged larger, by actual measurement, than those of the plains, with stouter and considerably longer and more spreading horns."

Later, Allen (1877:448) wrote: "The bisons formerly living in the parks and valleys of the central portion of the Rocky Mountain chain doubtless did often grow to a larger size than those of the plains . . . and, being less subjected to the bleaching effects of the elements in their partially wooded retreats, would naturally have a darker and perhaps softer pelage. . . . The small bands now lingering here and there in the mountains . . . may be in part remnants of a former larger mountain form, but certainly a part of them are actually recent migrants from the plains. In 1871 I was able to trace the migration of a small band up the valley of the South Platte, and across South Park. . . . Specimens of the 'mountain bison' sent in a fresh state from Colorado . . . certainly presented no appreciable differences from winter specimens from the plains. The mountain race of the bison was apparently a little larger than the buffalo of the plains, and doubtless was nearly identical with the race known farther northward as the 'wood buffalo.'"

Today it is generally conceded that two subspecies of bison occurred in Colorado, the plains bison *(B. b. bison)* and the mountain bison *(B. b. athabascae)*. As the above quotations from J. A. Allen indicate, however, relationships between the two kinds are obscure. No concensus is available on the relative sizes of the two kinds (see Roe, 1970:67). The wood bison of Canada is larger than the plains bison, but Coloradan mountain bison may have been somewhat smaller than the plains subspecies, or of comparable size (Warren, 1942: 296). Brewer (1871:221) described the mountain bison (on the basis of hearsay) as " . . . quite unlike the buffalo of the plains, smaller in size, the hair longer, more shaggy, and blacker. . . ." Likewise, J. A. Allen (1877:448) described montane animals as darker than individuals from the plains, but Figgins (1933: 30) described the montane population (as a new subspecies, *B. b. haningtoni*) as paler in color.

Because of the obvious confusion surrounding nominal races of *B. bison*, and the improbability of rectifying the situation at this late date, no attempt is made here to differentiate records of occurrence by subspecies, nor are distributions mapped.

Records of occurrence.—See account of *B. b. bison.*

Bison bison bison (Linnaeus)

[Bos] bison Linnaeus, Systema Naturae, 10th ed., 1:72, 1758; type locality, central Kansas (see Hershkovitz, 1957).

B[ison]. bison, Jordan, Manual of the vertebrate animals . . . , 5th ed., p. 337, 1888.

Distribution in Colorado.—Formerly Great Plains and Wyoming Basin (not mapped).

Comparison.—For comparison with *B. b. athabascae*, see account of that subspecies.

Records of occurrence.—Specimens examined, none.

Additional records: All Coloradan records from the primary zoological literature are included here, inasmuch as any subspecific distinctions made would be based on supposition. Records are from Fryxell (1928:131-135) unless otherwise noted. MOFFAT COUNTY: Cedar Springs, 6 mi. W Craig (Felger, 1910:143). ROUTT COUNTY: California Park (Bergtold, 1929:170); Bear's Ears Mountain (Felger, 1910:143). JACKSON COUNTY: Higho (Cary, 1911:61); between Illinois and Grizzly creeks. LARIMER COUNTY: near Chambers Lake, NE 1/4 sec. 6, T. 7 N, R. 75 W, 9200 ft.; SE 1/4 sec. 5, T. 7 N, R. 75 W; above Lost Lake, sec. 7, T. 6 N, R. 73 W; Dunraven Meadows, sec. 18, T. 6 N, R. 73 W; E slope Hague's Peak, 12,100 ft.; Thatchtop Mountain, 12,600 ft.; Horseshoe Park; N end of Estes Park; NE 1/4 sec. 18, T. 5 N, R. 72 W; E of Mary's Lake; Roaring Fork, Big Thompson River. MORGAN COUNTY: American Bottoms, near present-day town of Brush. RIO BLANCO COUNTY: Lost Park, near Marvine Lake (Bergtold, 1929:170). GARFIELD COUNTY: Mud Springs, 25 mi. N Rifle (Bergtold, *loc. cit.*); vicinity of Glenwood Springs (Bergtold, *loc. cit.*); divide between Piceance and Rifle creeks (Bergtold, *loc. cit.*); Rifle Creek (Felger, 1910:143). GRAND COUNTY: Whitely's Peak (Coues, 1879: 221). PARK COUNTY: "Mount Lincoln, far above timberline" (J. A. Allen, 1874:55); Mosquito Gulch, above Alma, 11,500 ft. (Warren, 1927a:60); head of Rock Creek (Figgins, 1933:30); Lost Park (Cory, 1912:89); near Buffalo Springs (J. A. Allen, 1874: 54). GUNNISON COUNTY: Irwin, 10,700 ft. (Warren, 1927a:60); West Elk Mountains (Warren, 1906: 239). EL PASO COUNTY: near Seven Lakes (Warren, 1906:239). BACA COUNTY: near Springfield (Warren, *loc. cit.*).

Ovis canadensis

BIGHORN

The bighorn formerly occurred at moderate elevations in mountainous parts of western North America, from British Columbia southward to northern Mexico. In Colorado, the historical range included much of the central and western parts of the state. Today, however, the range is fragmented, and bighorns occur in more than 50 disjunct bands in less accessible parts of the higher mountains. Extensive migrations of the past have given way to short altitudinal movements between summer and winter ranges. In the past, winter range was in the foothills and protected areas of mountain valleys (see Douglas, 1938).

By the early days of settlement, bighorns already were coming to be restricted to the high mountains. Brewer (1871:220) noted their occurrence on the ranges about South Park in 1869. J. A. Allen (1874:55) reported bighorns as occasional about Montgomery in 1871, but ". . . retiring in summer to the most inaccessible parts of the mountains." Earlier travelers had reported sign of bighorns abundant in the foothills. Members of Pike's expedition shot bighorns on the Arkansas River, just above Royal Gorge (Jackson, 1966:363). Long's party encountered remains of bighorns along West Plum Creek, south of the present-day town of Sedalia (James, 1823). The animals were eliminated from Mesa Verde in the early part of the present century (see Cahalane, 1948:257, and Anderson, 1961:64), but were reintroduced in 1946 from a herd near Tarryall. J. A. Allen (1893:70) noted that bighorns were killed at long intervals in the vicinity of Florida, La Plata County.

Considerable research has been conducted on Coloradan bighorns. Packard (1946) studied the species in Rocky Mountain National Park, and C. C. Spencer (1943) made observations on bighorns in the Tarryall Mountains. Occasional hybridization occurs between bighorns and domestic sheep. Young and Manville (1960) provided notes on the incidence of such hybridization. Within historic times, at any rate, bighorns have been subject to periodic decimation, usually from lung-worm and hemorrhagic septicemia (see Potts, 1937, 1938, and Hunter and Pillmore, 1954). Generally, die-offs are associated with over-concentration on marginal winter range.

The natural history and status of the bighorn in the United States was reviewed in the thorough monograph by Buechner (1960). Moser (1962) provided an excellent summary of the biology of the bighorn in Colorado, including data on distribution, reproduction, food habits, and management. Capp (1968) emphasized bighorn sheep in his review of the biology of ungulates of Rocky Mountain National Park.

In Colorado, the bighorn is a game animal, subject to careful management (including an ambitious program of transplanting) and a limited hunting season. According to official reports, there were 552 applicants for bighorn permits in 1969; 145 permits were issued and 37 rams were harvested. Over the 12-year period 1953-1964, an average of 51 animals

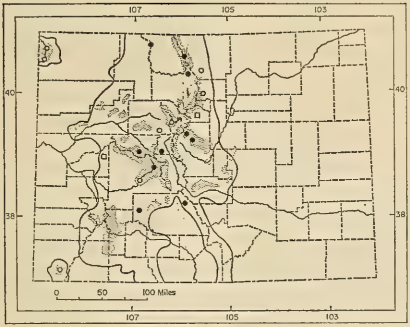


FIG. 116. Distribution of *Ovis canadensis canadensis* in Colorado. Stippled area denotes approximate extent of present range; solid line indicates approximate boundary of historic range (after Moser, 1962:10).

was harvested annually (range, 25 in 1959 to 79 in 1954). Estimates of the total bighorn population in recent years have ranged around 3000 animals. Largest numbers occur in the Front Range and the upper Poudre River drainage, the San Juan Mountains, and the Sawatch Range.

The subspecies of *O. canadensis* were revised by Cowan (1940).

Ovis canadensis canadensis Shaw

Ovis canadensis Shaw, Naturalists' Miscellany, 51: text to pl. 610, February 1804 (see Osgood, 1913, 1914); type locality, Bow River, near Exshaw, Alberta.

Nemorhoedus palmeri Cragin, Bull. Geol. Soc. America, 11:611, August 1910; type locality, cave on Glen Eyrie Estate, 5 mi. NW Colorado Springs, El Paso Co., Colorado (see G. S. Miller, Jr., 1930).

Distribution in Colorado.—Formerly widespread in foothills and mountains of central and western parts of state; presently mostly restricted to parts of higher mountains (Fig. 116).

Records of occurrence.—Specimens examined, 18, distributed as follows: JACKSON COUNTY: Mount Zirkel, 2 (1 DMNH, 1 USNM). LARIMER COUNTY: Rawah Peak, 11,500 ft., 1 (USNM); Clark's Peak, 12,000 ft., 2 (USNM). GRAND COUNTY: sec. 10, T. 5 N, R. 76 W, Arapahoe National Forest, 1 (USNM). JEFFERSON COUNTY: Denver Mountain Park, 1 (USNM). PITKIN COUNTY: Avalanche Creek, near Snowmass, 1 (USNM). LAKE COUNTY: Twin Lakes, 2 (USNM). PARK COUNTY: Jefferson, 2 (USNM); Sheep Rock, Kenosha Range, SE of Jefferson, 1 (USNM). GUNNISON COUNTY: Taylor River Canyon, 1 (USNM). SAGUACHE COUNTY: Villa Grove, 2 (USNM); Elk Creek, sec. 32, T. 45 N, R. 1 E, 1 (USNM). County unknown: *Ute and Ulay Mine*, 1 (KU).

Additional records (Cowan, 1940:541, unless otherwise noted): MOFFAT COUNTY: Ladore Canyon; *Green River, 4 mi. N mouth Yampa River;* junction Yampa and Green rivers. LARIMER COUNTY: Estes Park (KU catalog, specimen not found). EAGLE COUNTY: just W of Vail Pass (Hunter and Kinghorn, 1950:193); Holy Cross [White River] National Forest. BOULDER COUNTY: " . . . main range near Boulder" (Coues, 1879:221). CLEAR CREEK COUNTY: no precise locality (Trippe, 1874: 224). DELTA COUNTY: no precise locality. GUNNISON COUNTY: 3 mi. NE Almont. County unknown: Wiggins Fork.

SPECIES OF PROBABLE OCCURRENCE

In addition to the 121 species of mammals known with certainty in Colorado, 10 species have geographic and ecological distributions in nearby states that suggest their probable occurrence in Colorado. Brief accounts of those species follow.

Myotis velifer grandis Hayward, 1970 or *M. v. velifer* (J. A. Allen, 1890).—*Myotis velifer* is a cave-roosting bat. In New Mexico, the species is known to occur north to Fort Wingate, McKinley County (Miller and Allen, 1928:91), and in Kansas, it is known westward to Meade County (Jones *et al.*, 1967:12). Occasional individuals might be expected in either southwestern or southeastern Colorado.

Euderma maculatum (J. A. Allen, 1891).—The spotted bat is known from scattered localities throughout western United States, and doubtless occurs in Colorado. Localities of record nearest the state are the Abajo Mountains of San Juan County, Utah (Benson, 1954; Williams *et al.*, 1970), and Ghost Ranch, 12 mi. NW Abiquiu, Rio Arriba Co., New Mexico (Constantine, 1961b).

Plecotus phyllotis (G. M. Allen, 1916).—*Plecotus phyllotis* was reported from a place 5 mi. N of Blanding, San Juan Co., Utah, by Black (1970). That locality is less than 25 airline miles from the Colorado boundary, suggesting that perhaps occasional individuals of this species occur in southwestern Colorado.

Spermophilus franklinii (Sabine, 1822).—Franklin's ground squirrel is a mammal of the tall-grass prairie. In Kansas, the species is known westward to Trego County (Cockrum, 1952:129). In Nebraska, *S. franklinii* is known to occur along the North Platte River to Morrill County (Jones, 1964:125). The species apparently has extended its range westward along river systems within historic times, probably in response to alteration of habitat by irrigated agriculture (Jones, *loc. cit.*). If trends apparent in Nebraska should continue, Franklin's ground squirrel may come to occur in Colorado along the South Platte or Republican rivers, or Frenchman Creek.

Glaucomys sabrinus lucifugus Hall, 1934. —The northern flying squirrel possibly occurs in that part of Moffat County that lies west of the Green River. The species is known to occur in Daggett and Uintah counties, Utah (Durrant, 1952:153). Along the Green River in Colorado, timber is sufficiently heavy locally to support individuals of the species, but on the plateau (Diamond Mountain) intervening between the canyon and Mount Lena, habitat is discontinuous at present.

Perognathus parvus clarus Goldman, 1917. —The Great Basin pocket mouse is known from a number of localities in Sweetwater County, Wyoming, but to date is unreported from that state from east of the Green River (Long, 1965:617). Nonetheless, the species must be considered as possibly occurring in shrublands of northwestern Moffat County, Colorado.

Dipodomys spectabilis clarencei Goldman, 1933.—The banner-tailed kangaroo rat occurs widely in New Mexico and adjacent states. The type locality of the northernmost race is at Blanco, San Juan County, a town on the Animas River about 20 miles south of the Colorado boundary. Harris (1963:37) reported specimens from the vicinity of Bloomfield, San Juan Co., New Mexico. Should *Dipodomys spectabilis* be found to occur in Colorado, it most probably will be in the open country in the vicinity of Four Corners, Montezuma County.

Neotoma stephensi relicta Goldman, 1932. —Stephens' woodrat is a small, hairy-tailed member of the *Neotoma lepida*-group, generally confined to the Colorado Plateau south of the San Juan River. The species possibly occurs in extreme southwestern Colorado. Harris (1963:41) reported a specimen from San Juan County, New Mexico, at a locality (N 1/2, SW 1/4 sec. 25, T. 32 N, R. 7 W) within a mile of the Colorado boundary near La Boca, La Plata County. I have examined a specimen (DMNH 2509) from a place 8 mi. SW of Four Corners, Apache Co., Arizona.

Synaptomys cooperi relictus Jones, 1958.—The southern bog lemming occurs over the northeastern quarter of the United States and in parts of southern Canada. Populations occur in suitable habitat in western Kansas and Nebraska. Jones (1958a:387) considered the population in southwestern Nebraska to be a relict, occurring only along Rock Creek in Dundy County. The race may occur also in the vicinity of Wray, Yuma Co., Colorado. Other eastern species of mesic situations (for example, *Cryptotis parva, Blarina brevicauda, Microtus pennsylvanicus*) occur locally in eastern Yuma County.

Mustela nivalis campestris Jackson, 1913.—The least weasel has been reported mistakenly from Denver (see accounts of questionable validity, beyond). Whereas the species is not to be expected in that part of Colorado, it may possibly occur in the northeastern part of the state. *Mustela nivalis* has been reported from Garden County, Nebraska (Swenk, 1926:321).

Subspecies of Possible Occurrence in Colorado

A number of Coloradan species are represented in adjacent states by subspecies that may, in fact, be found to occur in Colorado as well. Such subspecies are listed here without comment; for further remarks, see accounts of the respective species.

Sorex cinereus haydeni
Lasiurus borealis teleotis
Marmota flaviventris nosophora
Spermophilus variegatus utah
Tamiasciurus hudsonicus baileyi
Tamiasciurus hudsonicus mogollonensis
Perognathus flavus flavus
Perognathus flavus piperi
Dipodomys ordii uintensis
Peromyscus crinitus doutti
Peromyscus leucopus aridulus
Peromyscus boylii utahensis
Neotoma cinerea macrodon

Clethrionomys gapperi uintaensis
Microtus pennsylvanicus aztecus
Microtus longicaudus alticola
Microtus ochrogaster taylori
Zapus princeps utahensis
Vulpes vulpes regalis
Urocyon cinereoargenteus ocythous

RECORDS OF QUESTIONABLE VALIDITY

Dasypus novemcinctus.—The nine-banded armadillo was reported from Colorado by Hahn (1966). On 3 July 1963, a subadult female was captured alive by a rancher at a place 20 mi. S of Walsh, Baca County. The animal was taken to Springfield and displayed there in a department store, but to my knowledge, was not preserved as a scientific specimen.

In recent years the armadillo has greatly expanded its range northward in the United States. In Kansas, the species has been recorded as far north as Sheridan County (Smith and Lawlor, 1964). I suspect that at least intermittent populations are, or soon will be, established in southeastern Colorado, particularly along the Cimarron River and its affluents. However, for the present, I regard the armadillo as too poorly known in Colorado to consider it as a *bona fide* member of the fauna.

Mustela nivalis.—Seton (1933) reported a least weasel (as *Mustela rixosa*) to have been captured by a dog in a vacant lot in Denver on 3 April 1932. The weasel was mounted by a Denver taxidermist. F. W. Miller (1933b) re-examined the specimen and then submitted it to Professor E. R. Hall for examination. Hall concluded that the specimen was of the population now known as *Mustela erminea muricus*, an identification with which I concur. The specimen is preserved in the Denver Museum of Natural History (DMNH 2510).

The least weasel may eventually be found to occur in northeastern Colorado. Swenk (1926:321) reported the species from Oshkosh, Garden Co., Nebraska, a locality on the North Platte River within 30 miles of the Colorado boundary.

Martes pennanti.—J. A. Allen (1874:54) reported that the fisher was "said to be more or less common" in Park County, Colorado, in the summer of 1871. Coues (1877:68) wrote that "Mr. Allen has recently ascertained its presence in Colorado." Cary (1911:191) considered any Coloradan report of the fisher to be questionable, and no positive evidence of the occurrence of *M. pennanti* in the Southern Rocky Mountains is available to date. The southernmost record of the species in the Rockies is based on tracks observed at Trial Lake in the Wasatch Mountains, Summit Co., Utah (Durrant, 1952:425). Hoffmann *et al.* (1969:596) suspected that, in fact, the southern limit of the fisher was in northwestern Wyoming and in central Idaho.

Felis onca.—Seton (1920:241) discussed a supposed record of the jaguar in Colorado. A trapper, Rufus B. Sage, wrote that one of his party had "encountered a strange looking animal in his excursions, which from his descriptions, must have been of the Leopard family." That was in November of 1843, perhaps in Estes Park (see Warren, 1942:308), and certainly in the South Platte drainage about Longs Peak. The northernmost authenticated records of the jaguar are in north-central Arizona (Cockrum, 1960:243) and near Springer, Colfax Co., New Mexico (Hill, 1942:78). Perhaps the problematic Coloradan report represents an immature mountain lion, *Felis concolor*. Seton (1929, 1:14) and Warren (1942:308) admitted the presence of jaguars in north-central Colorado as a bare possibility, but I hesitate to concede even that.

Oreamnos americanus.—For comments on early reports of the mountain goat in Colorado, see accounts of introduced species, beyond.

INTRODUCED SPECIES

The number of mammalian species introduced into native habitats in Colorado by man, either deliberately or inadvertently, doubtless is large and incompletely documented. For most such species, ecesis is impossible, and viable breeding populations are not established. However, some commensals are well established locally, as is the mountain goat, introduced intentionally. The fox squirrel, treated herein as a native mammal, was introduced in eastern Colorado before natural extensions of the range carried the species to the state.

Where exotic species become established, it is almost invariably at the expense of one or more native mammals. The presence of adventives upsets the co-evolutionary balance of natural ecosystems. The introduction of exotic wildlife should be discouraged. Where particular local conditions indicate the permissibility of limited introductions, all populations involved must be kept under the closest scrutiny.

Marmosa sp.—Neotropical mouse-opossums (genus *Marmosa*) once were carried frequently to temperate North America with shipments of bananas from Central America. Warren (1942:306) gave notes on murine opossums captured at Colorado Springs in 1905 and 1913. Records were attributed to *Marmosa alstoni* and *Marmosa [mexicana] zeledoni*, but in the absence of specimens, those identifications are best not considered definitive.

Erinaceus europeus.—Hedgehogs were released by General W. J. Palmer on his estate at Glen Eyrie, northwest of Colorado Springs, in the belief that they would kill rattlesnakes. Others were released on Cheyenne Mountain. Later, a hedgehog was captured alive near Colorado Springs. Dates of these events are unknown (Warren, 1942:307).

Mus musculus.—The house mouse occurs widely in North America, principally as a commensal of man. In my experience, the species is essentially ubiquitous in settled parts of Colorado. However, the mice seldom are found away from the immediate vicinity of buildings. Save in gravely disturbed situations, house mice seem not to be invasive in native communities. As indicated previously, a detailed study of relationships between *M. musculus* and small indigenous rodents, especially *Reithrodontomys megalotis*, would be of interest. House mice and western harvest mice occupy closely comparable situations, the adventive species being prevalent in and near settlements and on grossly disturbed sites.

Rattus norvegicus.—The Norway rat occurs in Colorado chiefly in larger cities and towns of the Eastern Slope. Silver (1927) presented historical data on *Rattus* in Colorado. The species apparently does not occur widely (if at all) on the Western Slope. Residents of Grand Junction, the largest city of western Colorado, informed me that rats do not occur there, the bushy-tailed woodrat being a frequent commensal in suburban areas. A study of the status and ecology of the Norway rat in Colorado would be of interest, for this murid is near the limits of its tolerances there and may be in competition with one or more native species of the genus *Neotoma*.

I have no information on the black rat, *Rattus rattus* in Colorado, although this commensal species may be found to occur in such urban centers as Denver, Colorado Springs, or Pueblo.

Myocastor coypus.—The nutria is a South American rodent raised widely in North America for its pelt, which is of variable commercial value. The present extent of the nutria-farming industry in Colorado is not known to me. I have examined a single Coloradan specimen, an escapee from captivity at Colorado Springs (CSU 9921).

Mustela putorius.—According to Warren (1942:307), feral European ferrets have been captured in Colorado on a few occasions. Records were listed from Salida, Pueblo, and Denver. I have seen none of the specimens mentioned by Warren.

Oreamnos americanus.—The mountain goat is a mammal of the Northern Rocky Mountains and is not native to Colorado. Nine goats from Montana were introduced in 1949 on Mount Shavano in the Collegiate Range, the southern part of the Sawatch Mountains. Six additional animals were released nearby in 1952. Eleven goats from Idaho and five from the introduced population on the Black Hills were planted in 1961 on Mount Evans, Clear Creek County. Other small bands now occur in the Gore Range and in the San Juan Mountains near Lake City.

Since its introduction, the mountain goat has been under close surveillance by the Division of Game, Fish and Parks. Of particular interest has been the effects of goats on range utilized also by domestic and bighorn sheep. Limited hunting of mountain goats has been

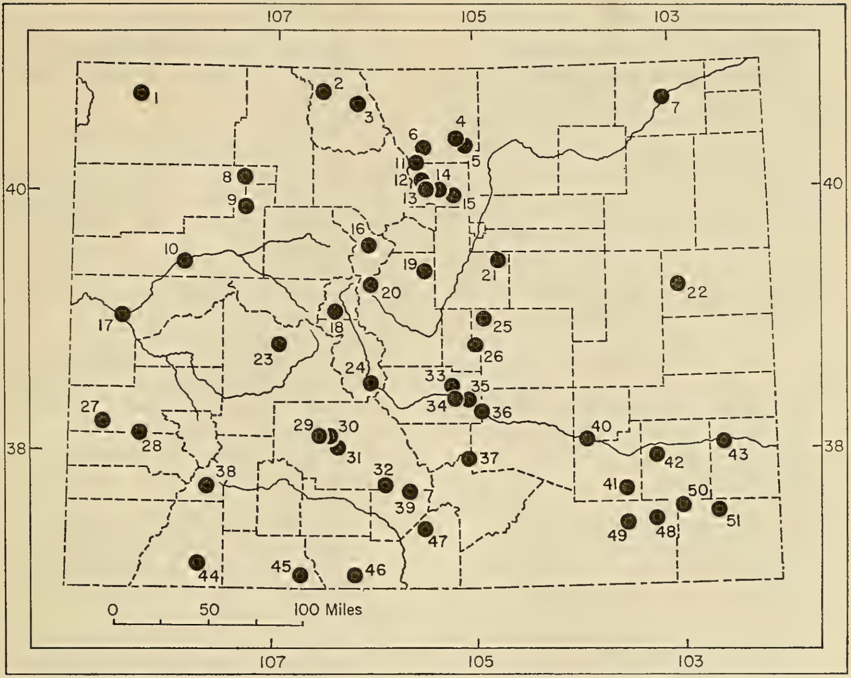


FIG. 117. Mammalian type localities in Colorado. For explanation, see text.

allowed since 1964. Annual harvest from 1964 through 1969 was: 4, 4, 3, 14, 15, 20.

Studies of the mountain goat in Colorado include Hibbs (1967) and Hibbs *et al.* (1969). Hibbs (1966) reviewed literature on the ecology of *Oreamnos americanus.*

Coues and Yarrow (1875:68), in an account of the moutain goat, reported "one individual seen in Colorado by Lieutenant Marshall's party." Trippe (1874:224) noted the mountain goat (as *Aploceros montanus*) among the mammals of Clear Creek and Gilpin counties. There is no concrete evidence to indicate that the mountain goat has occurred in Colorado in Recent times prior to its introduction by man. Perhaps early reports represent sightings of bighorn ewes.

TYPE LOCALITIES OF MAMMALS IN COLORADO

Sixty-six nominal mammalian taxa have been described with type localities in Colorado. An outline resumé of these names follows, arranged by county where possible. Entries consist of the type locality, as currently understood, the original name of the taxon with author and date, and the name under which a given nominal taxon is treated in the present checklist. Numbers identify localities as plotted in Fig. 117.

MOFFAT COUNTY.

1. Little Snake River, S of Sunny Peak.—*Myotis lucifugus phasma* Miller and Allen, 1928 *[Myotis yumanensis yumanensis].*

JACKSON COUNTY.

2. 8 mi. W Higho Post Office.—*Marmota flaviventer campioni* Figgins, 1915 *[Marmota flaviventris luteola].*
3. Sandhills, 5 mi. E Canadian River, E of Walden.—*Lemmiscus curtatus levidensis* Goldman, 1941 *[Lagurus curtatus levidensis].*

LARIMER COUNTY.

4. Arkins.—*Spilogale tenuis* A. H. Howell, 1902 *[Spilogale putorius gracilis].*
5. Loveland.—*Sciurus aberti ferreus* True, 1900; *Perognathus infraluteus* Thomas, 1893 *[Perognathus fasciatus infraluteus]; Zapus hudsonius preblei* Krutzsch, 1954.
6. Estes Park.—*Sorex tenellus nanus* Merriam, 1895 *[Sorex nanus]; Vesperimus nasutus* J. A. Allen, 1891 *[Peromyscus difficilis nasutus]; Ursus shoshone* Merriam, 1914 *[Ursus arctos].*

LOGAN COUNTY.

7. South Platte River.—*Canis velox* Say, 1823 *[Vulpes velox velox].*

RIO BLANCO COUNTY.

8. Pagoda Peak.—*Ochotona figginsi* J. A. Allen, 1912 *[Ochotona princeps figginsi].*
9. Marvine Mountain.—*Mustela caurina origenes* Rhoads, 1902 *[Martes americana origenes].*

GARFIELD COUNTY.

10. 8 mi. W Rifle.—*Perognathus apache caryi* Goldman, 1918.

BOULDER COUNTY.

11. Twin Peak, near Longs Peak.—*Phenacomys preblei* Merriam, 1897 *[Phenacomys intermedius intermedius].*
12. Ward.—*Evotomys galei* Merriam, 1890 *[Clethrionomys gapperi galei].*
13. 3 mi. S, 1/2 mi. E Ward.—*Eutamias umbrinus montanus* White, 1953.
14. Gold Hill.—*Eutamias amoenus operarius* Merriam, 1905 *[Eutamias minimus operarius]; Neotoma fallax* Merriam, 1894 *[Neotoma mexicana fallax].*
15. Boulder.—*Eptesicus pallidus* Young, 1908 *[Eptesicus fuscus pallidus].*

SUMMIT COUNTY.

16. Blue River.—*Ursus bairdi* Merriam, 1914 *[Ursus arctos].*

MESA COUNTY.

17. Grand Junction.—*Ammospermophilus leucurus pennipes* A. H. Howell, 1931; *Thomomys bottae howelli* Goldman, 1936.

LAKE COUNTY.

18. Twin Lakes.—*Ursus macrodon* Merriam, 1918 *[Ursus arctos].*

PARK COUNTY.

19. Head of Rock Creek.—*Bison bison haningtoni* Figgins, 1933 *[Bison bison athabascae].*
20. Montgomery, near Mount Lincoln.—*Ochotona saxatilis* Bangs, 1899 *[Ochotona princeps saxatilis].*

DOUGLAS COUNTY.

21. D'Arcy Ranch, 2 mi. N Parker.—*Thomomys talpoides macrotis* F. W. Miller, 1930.

KIT CARSON COUNTY.

22. Flagler.—*Thomomys talpoides retrorsus* Hall, 1951.

GUNNISON COUNTY.

23. Smith Trail, 2 mi. W Crested Butte.—*Marmota flaviventer warreni* A. H. Howell, 1914 *[Marmota flaviventris luteola].*

CHAFFEE COUNTY.

24. Salida.—*Thomomys bottae internatus* Goldman, 1936; *Dipodomys ordii evexus* Goldman, 1933.

EL PASO COUNTY.

25. Monument Creek, SW of Monument.—*Castor canadensis concisor* Warren and Hall, 1939.
26. Glen Eyrie, 5 mi. NW Colorado Springs.—*Nemorhoedus palmeri* Cragin, 1910 *[Ovis canadensis canadensis].*

MONTROSE COUNTY.

27. 5 mi. W Naturita.—*Dipodomys ordii nexilis* Goldman, 1933.
28. Coventry.—*Sylvilagus auduboni [sic] warreni* Nelson, 1907; *Thomomys bottae optabilis* Goldman, 1936 *[Thomomys bottae aureus].*

SAGUACHE COUNTY.

29. Cochetopa Pass.—*Spermophilus gunnisoni* Baird, 1855 *[Cynomys gunnisoni gunnisoni]; Arvicola modesta* Baird, 1858 *[Microtus pennsylvanicus modestus].*

30. 2 1/2 mi. E Cochetopa Pass.—*Microtus montanus fusus* Hall, 1938.
31. Saguache Valley, 20 mi. W Saguache. —*Neotoma orolestes* Merriam, 1894 *[Neotoma cinerea orolestes].*
32. 9 mi. E Center.—*Perognathus flavus sanluisi* Hill, 1942.

FREMONT COUNTY.

33. Garden Park, near Cañon City.—*Conepatus mesoleucus fremonti* F. W. Miller, 1933.
34. Vicinity of Cañon City.—*Sciurus lateralis* Say, 1823 *[Spermophilus lateralis lateralis].*
35. 2 9/10 mi. E Cañon City.—*Thomomys bottae rubidus* Youngman, 1958.
36. Arkansas River, 26 mi. below Cañon City.—*Sciurus quadrivittatus* Say, 1823 *[Eutamias quadrivittatus quadrivittatus].*

CUSTER COUNTY.

37. Near Marion Reservoir [sec. 4, T. 24 S, R. 69 W], Wet Mountains.—*Marmota flaviventris notioros* Warren, 1934.

SAN JUAN COUNTY.

38. Silverton.—*Putorius streatori leptus* Merriam, 1903 *[Mustela erminea muricus].*

ALAMOSA COUNTY.

39. Medano Ranch, 15 mi. NE Mosca.—*Eutamias minimus caryi* Merriam, 1908; *Thomomys talpoides agrestis* Merriam, 1908; *Perognathus apache relictus* Goldman, 1938; *Reithrodontomys megalotis caryi* A. H. Howell, 1935 *[Reithrodontomys megalotis aztecus].*

OTERO COUNTY.

40. Mouth of Apishapa River.—*Vespertilio subulatus* Say, 1823 *[Myotis leibii ciliolabrum].*
41. 3 mi. NW Higbee.—*Neotoma mexicana scopulorum* Finley, 1953.

BENT COUNTY.

42. Prairie road to Bent's Fort.—*Pseudostoma castanops* Baird, 1852 *[Pappogeomys castanops castanops].*

PROWERS COUNTY.

43. Lamar.—*Geomys lutescens jugossicularis* Hooper, 1940 *[Geomys bursarius jugossicularis].*

LA PLATA COUNTY.

44. Florida.—*Thomomys fossor* J. A. Allen, 1893 *[Thomomys talpoides fossor]; Zapus princeps* J. A. Allen, 1893.

ARCHULETA COUNTY.

45. NE of Chromo.—*Taxidea taxus phippsi* Figgins, 1918 *[Taxidea taxus berlandieri].*

CONEJOS COUNTY.

46. Conejos River, 5 mi. W Antonito.—*Spermophilus tridecemlineatus blanca* Armstrong, 1971.

COSTILLA COUNTY.

47. Fort Massachusetts.—*Dipodomys montanus* Baird, 1855 *[Dipodomys ordii montanus].*

LAS ANIMAS COUNTY.

48. Irwin's Ranch [T. 29 S, R. 52 W].—*Eutamias quadrivittatus animosus* Warren, 1909 *[Eutamias quadrivittatus quadrivittatus].*
49. Purgatoire River, near mouth of Chacuacho Creek.—*Sciurus grammurus* Say, 1823 *[Spermophilus variegatus grammurus].*

BACA COUNTY.

50. Gaume's Ranch, Shellrock Canyon.—*Neotoma albigula warreni* Merriam, 1908.
51. I. N. Pruitt Farm, near Williams' Corner, 11 mi. N Springfield.—*Sigmodon hispidus alfredi* Goldman and Gardner, 1947.

PRECISE LOCALITIES UNKNOWN.

Rocky Mountains, probably park region of central Colorado.—*Sciurus fremonti* Audubon and Bachman, 1853 *[Tamiasciurus hudsonicus fremonti].*

Rocky Mountains, 38°.—*Reithrodon montanus* Baird, 1855 *[Reithrodontomys montanus montanus].*

Probably in foothills or western edge of plains.—*Ursus planiceps* Merriam, 1918 *[Ursus arctos].*

ZOOGEOGRAPHY OF MAMMALS OF COLORADO

Zoogeography is ". . . the scientific study of the distribution of animals on the earth . . ." (Udvardy, 1969:1). Zoogeographers have subdivided the field in diverse ways toward different ends. Darlington (1957:11) distinguished three levels of approach: 1) geographical distribution over the entire earth; 2) regional distribution over selected segments of the earth; 3) local distribution, including species geography ("the geographical distribution of species in relation to each other and to ecology and evolution"). Udvardy (1969:6) distinguished static faunistic and regional zoogeography from dynamic causal zoogeography. Further, he made a categorical distinction between zoogeography and ecology (*op. cit.*:7). Zoogeography is concerned with reasons for the arrival and settling of a species in a certain area. To inquire why and how a species is able to live in a particular area is an ecological question.

Simpson (1965:71-73) distinguished three approaches to zoogeography—geographical, ecological, and historical. Both geographical and ecological attributes of distributions are the product of evolutionary processes over time. Hence, truly explanatory models can be framed only on an historical basis.

The present study is concerned almost exclusively with the distribution of species, thus with the lowest levels of zoogeographic resolution. Broad questions of distributional autecology have been discussed in the foregoing accounts of species. When the ecological and geographic situation of a species has been described, it is of interest to know whether that situation is unique to the species, or a part of a larger pattern of distributions. Synthetic description is indicated. Patterns of distribution are considered from three standpoints—ecological, ecogeographic, and areal.

The ecological distribution of Coloradan mammals is treated in terms of life-zones and community-types. Species density, a crude index of environmental complexity, also is discussed. Ecogeographic analysis is by means of mammalian distributional areas, mapping-units highly analogous to biotic provinces in rationale, but predicated on the distribution of a single class of animals. Geographic attributes of ranges of species are used to define areographic theriofaunal elements.

Subspeciation, an evolutionary process leading to the formation of distinctive regional races, is an important consideration in species-level zoogeography. The coincidence of distributional limits and zones of intergradation indicates the presence of barriers of evolutionary importance. The occurrence of convergent modification in species of distinctive regional faunas points to broadly influential selective pressures shaping the adaptive constitutions of that fauna as a whole, and belies the notion that racial differences are non-adaptive. In addition, the level of incidence of distinct subspecies differs among faunal units defined by various criteria. Such differences most probably reflect a diversity of causal processes. One factor of importance, however, may be the relative length of time a given species has had to respond adaptively to unique regional environments. Differences in the extent of subspeciation may aid in the gross distinction of historical faunal strata. Such distinction involves no assumption of close consonnance of microevolutionary rates in different species, but only a rough correspondence between age in an area and adaptation to it.

Insofar as possible, ecological and historical zoogeography need to be approached separately, for each has a characteristic methodology and rationale. In the final analysis, however, both kinds of inquiry are necessary, for in my view, the ultimate problem of zoogeography is to ascertain the on-going historical succession of ecological conditions responsible for the evolution of observed distributional patterns.

ECOLOGICAL DISTRIBUTION

Life-zones

Merriam (1890) described the marked vertical stratification of the biota of the San Francisco Mountain area of Arizona in terms of life-zones. The zones were defined empirically, mostly on the basis of distributions of higher plants, birds, and mammals. It was observed that ". . . temperature and humidity are the most important causes governing distribution, and that temperature is more important than humidity" (*op. cit.*:26). In particular, temperature during the reproductive season was seen to dictate the distribution of organisms. The emphasis of the report on the San Francisco Mountains was description, not the establishment of a theoretical basis for observed zonation. Detailed maps of life-zones of the Little Colorado Desert-San Francisco Mountain area were included, as was a "provisional biological map of North America, showing the principal life areas" (*op. cit.*:pls. 1-5).

Later, Merriam (1894) attempted to formulate temperature-based laws governing biotic distribution. "Animals and plants are restricted in northward distribution by the total quantity of heat during the season of growth and reproduction" (*op. cit.*:233). "Animals and plants are restricted in southward distribution by the mean temperature of a brief period covering the hottest part of the year" (*op. cit.*:234). Thus, in theory, life-zones might be defined by selected isotherms. The obvious difficulty of a single-factor emphasis, technical errors in its application, and the extension of the life-zone concept to embrace transcontinental areas, all contributed to a widespread rejection of the system (see, for example, Dice, 1923, and Shelford, 1932).

Much of the criticism of life-zones was directed at the theoretical model, not at descriptions of zonation by Merriam and his colleagues. Kendeigh (1954:163) pointed out that "insofar as the boundaries of life zones are not defined biotically but are made to agree with isotherms, they are highly questionable." In the western United States life-zones were, in fact, defined biotically, to the enduring credit of Merriam and the Bureau of Biological Surveys.

A. H. Miller (1951:532) observed that "anyone can 'see' life-zones or temperature correlated plant belts on mountain slopes. This circumstance was the stimulus and sound foundation of the system." Daubenmire (1938) advanced a similar argument. It was emphasized that observed zonation is a function of climax vegetation, and that vegetation is a reflection of climate. Vegetation does not respond to one or a few factors, but to a synergistic set of factors, against the background of local terrain. No meteorologic monitoring device approaches the comprehensive sensitivity of vegetation as an indicator of overall climate.

For recent discussion of the merits of life-zones in analysis of mammalian distributions, see Hoffmeister (1964). The journal *Plateau* devoted an issue (volume 37, number 2, 1964) to recognition of the ecological work of Merriam in northern Arizona. For objective critiques of the life-zone system, see Daubenmire (1938) and Udvardy (1969:247).

Life-zones of Colorado were described and mapped by Cary (1911). Figure 118 is a slight simplification of the map accompanying that work. Five life-zones were recognized in Colorado: Upper Sonoran, Transition, Canadian, Hudsonian, and Arctic-Alpine. The Upper Sonoran Life Zone comprises nearly one-half the area of the state, and consists of grasslands and shrublands at lower elevations on the eastern plains, in western valleys and basins, and on the floor of the San Luis Valley. The Upper Sonoran Zone in Colorado is so heterogeneous that Cary *(op. cit.)* subdivided it into four parts: juniper-piñon belt, Rio Grande drainage, Great Plains division, and Great Basin division. These subdivisions are hardly coordinate in rank or definition, but they improve Cary's analysis to a considerable extent. The piñon-juniper belt is a coherent ecological unit and forms essentially a sixth life-zone, interposed between Upper Sonoran and Transition. On the other hand, the Great Plains and Great Basin divisions are geographic units, horizontal subdivisions with generally historical bases. The Upper Sonoran Zone contains most of the cropland of Colorado and, hence, received special emphasis in the work of the Bureau of Biological Surveys.

The biota of the Transition Zone occupies the foothills and moderate elevations on plateaus and mesas. It was considered by Cary (*op. cit.*:33) ". . . a neutral distribution area . . . lying between the Boreal (Canadian) and Austral (Upper Sonoran) regions, and elements of both zones enter about equally into its composition." Over its extent in Colorado, *Pinus ponderosa* (ponderosa pine) is coextensive with the Transition Zone. North of the Uncompahgre Plateau, shrubs (especially *Quercus*) and Douglas-fir, *Pseudotsuga menziesii*, dominate the zone.

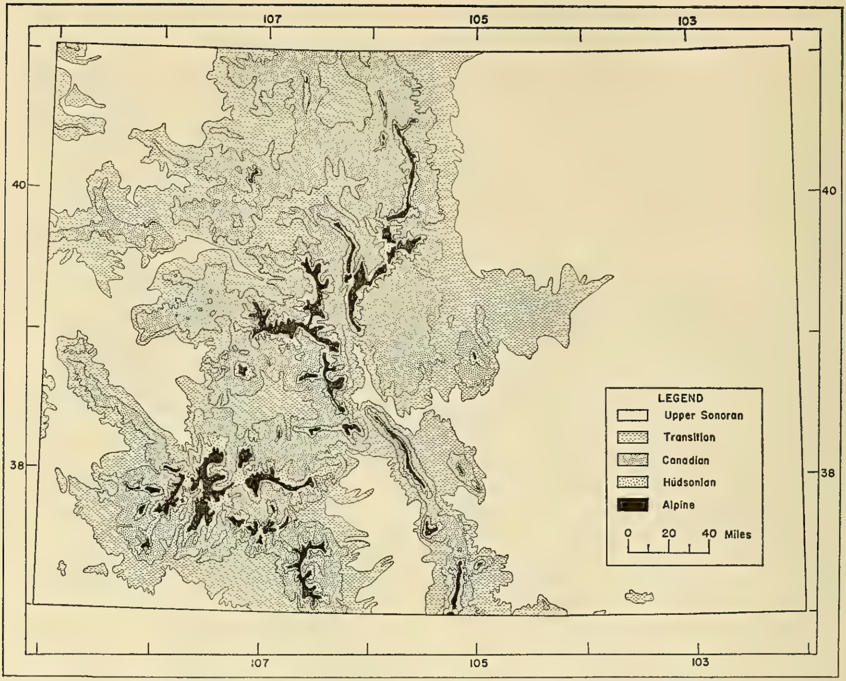


FIG. 118. Life-zones of Colorado (slightly modified after Cary, 1911).

The Canadian Zone in Colorado comprises the heavy forests of middle elevations, characterized by such species as *Populus tremuloides* (quaking aspen), *Pinus contorta* (lodgepole pine), and the heaviest stands of *Picea engelmannii* (Engelmann spruce). In addition, the open grasslands of South Park and the rolling sagebrush lands of Middle Park are mapped as parts of the Canadian Zone.

The Hudsonian Zone is the highest forested belt. Characteristic species of trees include *Picea engelmannii, Abies lasiocarpa* (subalpine fir), and locally, *Pinus flexilis* (limber pine) and *P. aristata* (bristlecone pine). The upper limit of the Hudsonian Zone is the tree-line. The Hudsonian was characterized by Cary (*op. cit.*:45) as a transitional area, composed of elements of the Alpine and Canadian zones.

The so-called "Arctic-Alpine Zone" comprises all areas above tree-line. The list of woody plants is dominated by dwarf species of *Salix*. In more exposed situations, ground-cover is largely of low or acaulescent herbs, mosses, and lichens.

Approximate vertical limits of life-zones in Colorado, following Cary (*op. cit.*:14), are indicated in table 24.

Distribution of 118 species of Coloradan mammals according to life-zones is given in table 25. The list excludes three species of documented, but occasional occurrence in Colorado (*Tadarida brasiliensis, Tadarida macrotis, Alces alces*). Cary (*op. cit.*) treated 107 species of mammals, according to present synonymy. The assignment of species to life-zones herein follows Cary except where a species was not treated by him. This analysis

TABLE 24
Extreme vertical limits (in feet) of life-zones in Colorado.
(From Cary, 1911:14.)

Life-zone	Northern Colorado		Southern Colorado	
	Northeast exposure	Southwest exposure	Northeast exposure	Southwest exposure
Upper Sonoran	up to 5,600	up to 6,500	up to 6,500	up to 7,800
Transition	5,600- 7,500	6,500- 8,200	6,500- 8,000	7,800- 9,000
Canadian	7,500-10,000	8,200-10,400	8,000-10,500	9,000-11,000
Hudsonian	10,000-10,900	10,400-11,600	10,500-11,200	11,000-12,000
Alpine	10,900 and up	11,600 and up	11,200 and up	12,000 and up

seeks to represent Cary's formalistic system, not my biases. Hence, complete concordance between table 25 and later discussion is not to be expected.

Of the 118 species tabulated, 49 are restricted to a single zone, 20 occur in two zones, 24 occupy three zones, 14 occur in four zones, and 11 occupy each of the five life-zones in the state. Of the 49 species restricted to a single zone, 47 occur in the Upper Sonoran and two occur in the Transition. No other life-zone has "endemic" mammals. The great number of species occurring only in the Upper Sonoran Zone is a reflection of the heterogeneity of that zone, as mentioned previously. As might be expected, the total number of species in each life-zone declines with increasing elevation, from 97 species in the Upper Sonoran to 17 species in the Alpine (Table 25).

A simple matrix of similarity indicating the degree of inter-relationship of mammalian faunas of Coloradan life-zones is given in table 26. Absolute numbers of species in common are indicated below the diagonal. Boldface numerals on the diagonal indicate numbers of species in each zone. Above the diagonal is an "index of faunal resemblance." The index computed is the "faunal resemblance factor" of Duellman (1965:677): $FRF = 2C/N_1 + N_2$, where C equals the number of species in common, N_1 equals the number of species in a given zone, and N_2 equals the number of species in a second zone. Obviously, a value of 0.000 in the index indicates no taxonomic resemblance between two zonal faunas, and an index of 1.000 would indicate identity. A value of 0.500 would indicate that one-half of the species in each of the two faunas is held in common. In view of this, it is important to note that the four indices lying nearest the diagonal in table 26 all are greater than 0.500. It is clear from that fact, and the fact that three zones have no "endemic" mammals, that definition of adjacent life-zones in Colorado in terms of characteristic mammals is impossible.

Physically, the best-defined of Coloradan life-zones is the Alpine, because tree-line is a prominent landmark on all major mountain ranges. Although of variable elevation (Table 24), tree-line generally is well defined. The Alpine Zone has a rather sizeable occasional fauna, but the alpine fauna admitted by Cary (*op. cit.*:50 and elsewhere) is small. No species is restricted to the Alpine Zone, nor to the Alpine and Hudsonian zones. Three alpine species occur through three life-zones, three kinds range through four life-zones (that is, throughout the vertical extent of the mountains), and 11 species (64.7 per cent of the alpine fauna) occur in all five Coloradan life-zones. Far from being mammalogically distinctive, the alpine fauna consists largely of euryzonal species.

Re-tabulation of zonal composition at the level of subspecies probably would tend to narow the zonal range of a number of taxa, and thus make life-zones more distinctive. A number of the mammalian indicators of life-zones noted by Cary are at the subspecific level, either explicitly or because of subsequent synonymy. Species in which highland and lowland races are distinguished include:

TABLE 25

Distribution of Coloradan mammals according to life-zones. (After Cary, 1911; an asterisk denotes species not treated by Cary and tabulated after more recent sources.)

Species	Upper Sonoran	Transition	Canadian	Hudsonian	Alpine
Didelphis marsupialis	X	—	—	—	—
Sorex cinereus	X	X	X	X	—
Sorex vagrans	—	X	X	X	—
Sorex nanus	X	X	X	X	—
Sorex palustris	—	X	X	X	—
*Sorex merriami**	X	—	—	—	—
*Microsorex hoyi**	—	—	X	—	—
Blarina brevicauda	X	—	—	—	—
*Cryptotis parva**	X	—	—	—	—
*Notiosorex crawfordi**	X	—	—	—	—
Scalopus aquaticus	X	—	—	—	—
Myotis lucifugus	X	X	—	—	—
Myotis yumanensis	X	—	—	—	—
Myotis evotis	X	X	—	—	—
*Myotis thysanodes**	X	X	—	—	—
Myotis volans	X	X	—	—	—
Myotis californicus	X	—	—	—	—
Myotis leibii	X	—	—	—	—
Lasionycteris noctivagans	X	X	X	—	—
Pipistrellus hesperus	X	—	—	—	—
Eptesicus fuscus	X	X	—	—	—
Lasiurus cinereus	X	X	X	—	—
Lasiurus borealis	X	—	—	—	—
Plecotus townsendii	X	X	—	—	—
Antrozous pallidus	X	—	—	—	—
Ochotona princeps	—	—	X	X	X
Sylvilagus floridanus	X	—	—	—	—
Sylvilagus nuttallii	—	X	X	X	—
Sylvilagus audubonii	X	—	—	—	—
Lepus americanus	—	—	X	X	X
Lepus townsendii	X	X	X	X	X
Lepus californicus	X	—	—	—	—
Eutamias dorsalis	X	—	—	—	—
Eutamias minimus	X	X	X	X	X
Eutamias quadrivittatus	X	X	X	—	—
*Eutamias umbrinus**	—	X	X	X	—
Marmota flaviventris	—	X	X	X	X
Ammospermophilus leucurus	X	—	—	—	—
Spermophilus richardsonii	X	X	X	—	—
Spermophilus tridecemlineatus	X	X	—	—	—
Spermophilus spilosoma	X	—	—	—	—
Spermophilus variegatus	X	X	—	—	—
Spermophilus lateralis	X	X	X	X	—
Cynomys ludovicianus	X	—	—	—	—
Cynomys leucurus	X	X	X	—	—

TABLE 25 (Continued)
Distribution of Coloradan mammals according to life-zones.
(After Cary, 1911; an asterisk denotes species not treated by Cary and tabulated after more recent sources.)

Species	Upper Sonoran	Transition	Canadian	Hudsonian	Alpine
Cynomys gunnisoni	X	X	X	—	—
Sciurus niger	X	—	—	—	—
Sciurus aberti	—	X	—	—	—
Tamiasciurus hudsonicus	—	X	X	X	—
Thomomys bottae	X	—	—	—	—
Thomomys talpoides	X	X	X	X	X
Geomys bursarius	X	—	—	—	—
Pappogeomys castanops	X	—	—	—	—
Perognathus fasciatus	X	—	—	—	—
Perognathus apache	X	—	—	—	—
Perognathus flavescens	X	—	—	—	—
Perognathus flavus	X	—	—	—	—
Perognathus hispidus	X	—	—	—	—
Dipodomys ordii	X	—	—	—	—
Castor canadensis	X	X	X	X	—
Reithrodontomys montanus	X	—	—	—	—
Reithrodontomys megalotis	X	—	—	—	—
Peromyscus crinitus	X	—	—	—	—
Peromyscus maniculatus	X	X	X	X	X
Peromyscus leucopus	X	—	—	—	—
Peromyscus boylii	X	—	—	—	—
Peromyscus truei	X	—	—	—	—
Peromyscus difficilis	X	X	—	—	—
Onychomys leucogaster	X	X	—	—	—
Sigmodon hispidus	X	—	—	—	—
Neotoma floridana	X	—	—	—	—
Neotoma micropus	X	—	—	—	—
Neotoma albigula	X	—	—	—	—
Neotoma lepida	X	—	—	—	—
Neotoma mexicana	X	X	—	—	—
Neotoma cinerea	X	X	X	X	—
Clethrionomys gapperi	—	X	X	—	—
Phenacomys intermedius	—	X	X	—	—
Microtus pennsylvanicus	X	X	X	—	—
Microtus montanus	—	X	X	X	X
Microtus longicaudus	X	X	X	X	X
*Microtus mexicanus**	—	X	—	—	—
Microtus ochrogaster	X	—	—	—	—
Lagurus curtatus	—	X	—	—	—
Ondatra zibethicus	X	X	X	—	—
Zapus hudsonius	X	—	—	—	—
Zapus princeps	—	X	X	X	—
Erethizon dorsatum	X	X	X	X	X
Canis latrans	X	X	X	X	X
Canis lupus	X	X	X	—	—

TABLE 25 (Continued)

Distribution of Coloradan mammals according to life-zones.
(After Cary, 1911; an asterisk denotes species not treated by Cary and tabulated after more recent sources.)

Species	Upper Sonoran	Transition	Canadian	Hudsonian	Alpine
Vulpes vulpes	X	X	X	X	X
Urocyon cinereoargenteus	X	—	—	—	—
*Vulpes macrotis**	X	—	—	—	—
Vulpes velox	X	—	—	—	—
Ursus americanus	—	X	X	X	—
Ursus arctos	X	X	X	X	X
Bassariscus astutus	X	—	—	—	—
Procyon lotor	X	X	—	—	—
Martes americana	—	—	X	X	X
Mustela erminea	—	X	X	X	X
Mustela frenata	X	X	X	X	X
Mustela nigripes	X	X	X	—	—
Mustela vison	X	X	X	—	—
Gulo gulo	—	—	X	X	—
Taxidea taxus	X	X	X	X	—
Spilogale putorius	X	X	—	—	—
Mephitis mephitis	X	X	X	—	—
*Conepatus mesoleucus**	X	—	—	—	—
Lutra canadensis	X	X	—	—	—
Felis concolor	X	X	X	X	—
Lynx canadensis	—	—	X	X	—
Lynx rufus	X	X	X	X	—
Cervus canadensis	X	X	X	X	—
Odocoileus hemionus	X	X	X	X	—
Odocoileus virginianus	X	X	—	—	—
Antilocapra americana	X	X	X	—	—
Bison bison	X	X	X	X	—
Ovis canadensis	X	X	X	X	X
Total (118 species)	97	63	53	39	17
Percentage of total fauna	82.2	53.4	44.9	33.0	14.4

TABLE 26

Resemblance of mammalian faunas of five Coloradan life-zones.
(See text for explanation; bold-face numerals on diagonal indicate total number of species in zone.)

Life-zone	Upper Sonoran	Transition	Canadian	Hudsonian	Alpine
Upper Sonoran	**97**	.600	.467	.324	.193
Transition	48	**63**	.776	.627	.350
Canadian	35	45	**53**	.847	.486
Hudsonian	22	32	39	**39**	.607
Alpine	11	14	17	17	**17**

Eutamias minimus, *Cynomys gunnisoni*, *Thomomys talpoides*, *Peromyscus maniculatus*, *Neotoma cinerea*, *Erethizon dorsatum*, *Canis latrans*, *Mephitis mephitis*, and *Lynx rufus*.

While such a level of analysis would make a definition of lower life-zones more precise locally, it would hardly solve the most important problem with the system in Colorado —the undue complexity of the Upper Sonoran Zone. As mentioned above, Cary (*op. cit.*) met this difficulty by proposing informal ecological and geographic subdivisions of the zone. Those subdivisions tend to be distinctive ecologically and historically, as is indicated beyond by other kinds of analyses. Probably the informal units are as important as some formal zones, or more so. Of the 47 species restricted to the Upper Sonoran Zone, 10 (21.3 per cent) occur only in piñon-juniper woodland or saxicoline shrub associations. An additional nine species (19.1 per cent) are restricted to deciduous woodland and associated mesic herb communities. To include plains grassland, riparian woodland, piñon-juniper woodland, and semidesert shrub communities in a single quasi-ecological unit attributes to that unit a misleadingly rich diversity of adaptive modes.

Life-zones, as described by Cary (*op. cit.*) after the philosophy of C. H. Merriam, are grossly descriptive of ecological distribution in Colorado. In discussing the distribution of particular species, adherents of the life-zone concept qualified the formal system with terminology descriptive of biotic communities, plant associations, site-types, and even historical factors. Life-zones have proved to be especially useful in mountainous parts of the Eastern Slope, where abrupt elevation of the mountains is the rule. In Colorado, as elsewhere in the mountain west, life-zones typically were mapped on the basis of the distribution of plant communities, not on the theoretical basis of temperature-summing. As a result, the map "Life zones of Colorado" (Cary, *op. cit.*: frontispiece) remains a generally useful ecological map, for the most part unbiased by the simplistic theorizing for which the life-zone concept has been widely criticized.

Community-types

It is a fact that an experienced observer can look at a given local site and predict with considerable accuracy the kinds of organisms that will be found to occur there. Even within relatively small areas, few species are truly ubiquitous. All have physiological and behavioral preferences and tolerances that lead to the occupation of one alternative site over another. These facts have stimulated a number of descriptive and predictive systems of ecological distribution. As discussed previously, the life-zone system of Merriam and his followers is essentially such an ecological scheme. Less formal, more detailed ecological classifications also have been proposed. Most such schemes are of only local or regional utility, but they are nonetheless important in establishing the gross ecological context of a given fauna. The term "community-type" (Dice, 1952:440) is appropriate for the semi-formal units of such systems. In the present instance, no extension beyond the political limits of Colorado is implied, so that community-types generally are related floristically as well as physiognomically. A. H. Miller (1951:540) called comparable units in California "ecologic formations."

Obviously, the number of community-types recognized is negotiable. Miller (*loc. cit.*) described ecological distribution of birds in California in 22 "ecologic formations"—plant communities, geologic features, and aquatic habitat-types. Gregg (1963:127) tabulated distribution of Coloradan ants in 63 plant communities or stand-types. Fourteen community-types are utilized herein, as follows: 1) Subhumid grassland; 2) Plains wetlands; 3) Riparian deciduous woodland; 4) Saxicoline brush; 5) Sagebrush; 6) Semidesert shrublands; 7) Pygmy conifer woodland; 8) Ponderosa pine woodland; 9) Montane forest; 10) Montane and subalpine meadow; 11) Subalpine forest; 12) Highland streambank and shoreline; 13) Aspen woodland; 14) Alpine meadow and fellfield.

Gross composition and structure of most of the community-types recognized is evident from the names applied to them. More detail is presented in introductory remarks on vegetation in Colorado. Other terms used in the present context are in need of qualification. *Riparian deciduous woodland* includes natural and cultural stands of trees on the eastern plains, but not phreatophytic communities along mountain streams. *Saxicoline brush* includes a diversity of shrub communities in rough, broken areas. These are dominated by a number of kinds of plants, including species of *Quercus* and *Cercocarpus montanus*. *Montane forest* denotes a relatively open forest of *Pseudotsuga, Picea*, and *Pinus*, and some associated seral stages or edaphic communities (Weber, 1967:4). Subalpine forest constitutes a relatively closed stand composed chiefly of *Picea engelmannii* and *Abies lasiocarpa*. Associated seral and edaphic communities are characterized by such species as *Pinus flexilis, Pinus aristata*, and *Populus tremuloides*. Major stands of quaking aspen are distinguished from both montane and subalpine forest as a separate community-type. The upper limit of subalpine forest is tree-line. *Alpine meadow* includes thickets of dwarf willows although such associations could perhaps as reasonably be considered a major community-type.

There are a number of problems with a classification of community-types such as that utilized here. Descriptors note only dominant vegetation or that which is most obvious. Generally only the tallest synusiae are considered. Distinctive attributes of lower synusiae are at best only implied, and at worst ignored completely. Seral stages, disturbed areas, local openings, and community-edge situations generally support more diverse mammalian faunas than more mature stands of a given community-type. A categorical system such as that outlined cannot deal adequately with such intermediate or developmental situations.

Just what constitutes a major community-type also is an important consideration. In the present scheme that question has been answered in a mammalogical context. Stands of quaking aspen are important in the hydrosere and on moist sites disturbed by fire in ponderosa woodlands, and montane and subalpine coniferous forests. Although mostly transitory, aspen stands are an important community-type from the viewpoint of mammalian ecological distribution because of the luxuriant herb synusiae characteristic of such stands. Aspen woodland is included as a major community-type. Lodgepole pine forest is not, although an argument could be made for its inclusion. Lodgepole pine covers extensive tracts in northern Colorado under suitable conditions. The trees form nearly pure stands, and an unbroken lodgepole forest has little understory and supports a meager mammalian fauna. Where the continuity of the forest is broken, the fauna is that of the montane forest of Douglas-fir and spruce.

Messicol communities—cultural vegetation in a broad sense—also have been excluded as a major community-type. Such communities obviously are widespread and important, but are omitted because of the present emphasis on natural patterns of distribution.

It should be obvious from the foregoing comments that the categorical community-types used are somewhat subjective. In addition, of course, they are not mutually exclusive. Some species range through nearly all community-types in search of food and shelter. It probably would be possible to construct a system of categories that was mutually exclusive; any ecological analysis might be refined to a description of site-types—unique, local combinations of vegetation, topography, exposure, microhabitat, soil, and other animals that make a given situation habitable. A study of such situations is autecology, not biogeography. The ultimate descriptive units carry no synthetic information because each includes a single species. Furthermore, such high levels of resolution are inadequate because of the complex relationships of site-types.

Discussion of a single example will illustrate the difficulties of ecological classifications. *Spermophilus tridecemlineatus* is a mammal of grasslands. On the eastern plains, however, all grasslands are not occupied equally. Thirteen-lined ground squirrels favor areas of short-grass on sandy soils typically on a slight slope with a southern to eastern exposure. In addition, the species occupies mountain parks and valleys, some quite small in size. Furthermore, openings in the semidesert shrublands of the San Luis Valley are occupied, as is the sagebrush community of northwestern Colorado.

TABLE 27

Distribution of Coloradan mammals in 14 community-types.

Species	Subhumid grassland (1)	Plains wetlands (2)	Plains riparian woodland (3)	Saxicoline brush (4)	Sagebrush (5)	Semidesert scrub (6)	Pygmy conifer woodland (7)	Ponderosa pine woodland (8)	Montane forest (9)	Montane, subalpine meadow (10)	Subalpine forest (11)	Highland streambank (12)	Aspen woodland (13)	Alpine meadow, fellfield (14)
Didelphis marsupialis	—	X	X	—	—	—	—	—	—	—	—	—	—	—
Sorex cinereus	—	X	—	—	—	—	—	X	X	X	X	X	X	X
Sorex vagrans	—	—	—	—	—	—	—	X	X	X	X	X	X	X
Sorex nanus	—	—	—	X	—	—	—	X	X	X	X	X	X	X
Sorex palustris	—	—	—	—	—	—	—	—	X	X	X	X	X	—
Sorex merriami	X	—	—	X	X	—	X	—	—	—	—	—	—	—
Microsorex hoyi	—	—	—	—	—	—	—	—	—	—	X	X	—	—
Blarina brevicauda	—	X	X	—	—	—	—	—	—	—	—	—	—	—
Cryptotis parva	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Notiosorex crawfordi	—	—	—	—	—	X	—	—	—	—	—	—	—	—
Scalopus aquaticus	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Myotis lucifugus	—	—	X	X	—	—	X	X	X	X	—	X	X	—
Myotis yumanensis	—	—	—	—	—	X	X	—	—	—	—	—	—	—
Myotis evotis	—	—	—	—	—	—	X	X	—	—	—	—	—	—
Myotis thysanodes	—	—	—	—	—	—	X	X	—	—	—	—	—	—
Myotis volans	—	—	—	X	—	—	X	X	—	—	—	X	X	—
Myotis californicus	—	—	—	X	—	X	X	—	—	—	—	—	—	—
Myotis leibii	X	X	—	X	—	—	—	—	—	—	—	—	—	—
Lasionycteris noctivagans	—	—	X	—	—	—	X	X	X	—	X	—	X	—
Pipistrellus hesperus	—	—	—	X	—	X	X	—	—	—	—	—	—	—
Eptesicus fuscus	—	—	X	X	—	—	X	X	X	—	—	—	X	—
Lasiurus borealis	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Lasiurus cinereus	—	—	X	—	—	—	X	X	—	—	X	—	X	—
Plecotus townsendii	—	—	—	X	—	—	X	X	—	—	—	—	—	—
Antrozous pallidus	—	—	—	—	—	X	X	—	—	—	—	—	—	—
Ochotona princeps	—	—	—	—	—	—	—	—	—	X	—	—	—	X
Sylvilagus floridanus	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Sylvilagus nuttallii	—	—	—	X	X	—	X	X	X	X	X	X	X	—
Sylvilagus audubonii	X	—	—	X	X	X	—	—	—	—	—	—	—	—
Lepus americanus	—	—	—	—	—	—	—	—	X	X	X	—	X	X
Lepus townsendii	X	—	—	X	X	X	X	X	X	X	X	—	X	X
Lepus californicus	X	—	—	X	—	X	X	—	—	—	—	—	—	—
Eutamias dorsalis	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Eutamias minimus	—	—	—	X	X	X	X	X	X	X	X	X	X	X
Eutamias quadrivittatus	—	—	—	X	—	—	X	X	X	X	—	—	—	—
Eutamias umbrinus	—	—	—	—	—	—	—	—	X	X	X	—	—	—
Marmota flaviventris	—	—	—	X	—	—	—	X	X	X	X	—	X	X
Ammospermophilus leucurus	—	—	—	X	—	X	X	—	—	—	—	—	—	—

TABLE 27 (Continued)
Distribution of Coloradan mammals in 14 community-types.

	Community-type													
Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Spermophilus richardsonii	X	—	—	—	X	—	—	X	—	X	—	—	—	—
Spermophilus tridecemlineatus	X	—	—	—	X	X	X	X	—	X	—	—	—	—
Spermophilus spilosoma	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Spermophilus variegatus	—	—	—	X	—	—	X	X	—	—	—	—	—	—
Spermophilus lateralis	—	—	—	X	X	—	X	X	X	X	X	—	X	X
Cynomys ludovicianus	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Cynomys leucurus	X	—	—	—	X	X	—	—	—	X	—	—	—	—
Cynomys gunnisoni	X	—	—	X	X	X	—	—	—	X	—	—	—	—
Sciurus niger	—	—	X	—	—	—	—	—	—	—	—	—	—	—
Sciurus aberti	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Tamiasciurus hudsonicus	—	—	—	—	—	—	—	—	X	—	X	—	—	—
Thomomys bottae	X	—	—	X	—	X	X	—	—	X	—	—	—	—
Thomomys talpoides	X	—	—	X	X	X	X	X	X	X	X	—	X	X
Geomys bursarius	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Pappogeomys castanops	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Perognathus fasciatus	X	—	—	X	—	—	—	—	—	—	—	—	—	—
Perognathus apache	X	—	—	X	—	X	X	—	—	—	—	—	—	—
Perognathus flavescens	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Perognathus flavus	X	—	—	X	—	X	—	—	—	—	—	—	—	—
Perognathus hispidus	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Dipodomys ordii	X	—	—	—	X	X	—	—	—	—	—	—	—	—
Castor canadensis	—	—	X	—	—	—	—	—	—	—	X	X	—	—
Reithrodontomys megalotis	X	X	—	—	—	—	—	—	—	—	—	—	—	—
Reithrodontomys montanus	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Peromyscus crinitus	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Peromyscus maniculatus	X	—	X	X	X	X	X	X	X	X	X	X	X	X
Peromyscus leucopus	—	X	X	—	—	—	—	—	—	—	—	—	—	—
Peromyscus boylii	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Peromyscus truei	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Peromyscus difficilis	—	—	—	X	—	—	X	X	—	—	—	—	—	—
Onychomys leucogaster	X	—	—	—	X	X	—	—	—	—	—	—	—	—
Sigmodon hispidus	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Neotoma floridana	X	—	X	—	—	—	—	—	—	—	—	—	—	—
Neotoma micropus	X	—	—	X	—	—	—	—	—	—	—	—	—	—
Neotoma albigula	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Neotoma lepida	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Neotoma mexicana	—	—	—	X	—	—	X	X	—	—	—	—	—	—
Neotoma cinerea	—	—	—	X	X	—	X	X	X	—	X	—	—	X
Clethrionomys gapperi	—	—	—	—	—	—	—	—	X	—	X	—	—	—
Phenacomys intermedius	—	—	—	—	—	—	—	—	X	—	X	—	—	—
Microtus pennsylvanicus	—	X	—	—	—	—	—	—	—	X	—	X	X	—
Microtus montanus	—	—	—	—	—	—	—	X	X	X	X	X	X	X
Microtus longicaudus	—	—	—	—	X	—	—	X	X	X	X	X	X	X
Microtus mexicanus	—	—	—	—	—	—	—	X	—	—	—	—	—	—
Microtus ochrogaster	X	X	—	—	—	—	—	—	—	—	—	—	—	—
Lagurus curtatus	X	—	—	—	X	—	—	—	—	—	—	—	—	—

TABLE 27 (Continued)
Distribution of Coloradan mammals in 14 community-types.

Species	Community-type 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Ondatra zibethicus	—	X	—	—	—	—	—	—	—	—	—	X	—	—
Zapus hudsonius	—	X	—	—	—	—	—	—	—	—	—	—	—	—
Zapus princeps	—	—	—	—	—	—	—	—	X	X	X	X	X	X
Erethizon dorsatum	—	—	X	X	X	X	X	X	X	—	X	—	X	X
Canis latrans	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Canis lupus	X	X	X	X	X	X	X	X	X	—	—	—	—	—
Vulpes vulpes	—	X	X	—	—	—	—	—	—	X	—	—	—	—
Urocyon cinereoargenteus	X	—	—	X	—	X	X	—	—	—	—	—	—	—
Vulpes macrotis	—	—	—	—	—	X	X	—	—	—	—	—	—	—
Vulpes velox	X	—	—	—	—	—	—	—	—	—	—	—	—	—
Ursus americanus	—	—	X	X	—	—	X	X	X	—	X	X	X	—
Ursus arctos	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bassariscus astutus	—	—	—	X	—	—	X	—	—	—	—	—	—	—
Procyon lotor	—	X	X	—	—	—	—	—	—	—	—	X	—	—
Martes americana	—	—	—	—	—	—	—	—	X	—	X	—	—	X
Mustela frenata	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Mustela erminea	—	—	—	—	—	—	—	—	X	X	X	X	X	X
Mustela nigripes	X	—	—	—	X	—	—	—	—	—	—	—	—	—
Mustela vison	—	—	X	—	—	—	—	—	—	—	—	X	—	—
Gulo gulo	—	—	—	—	—	—	—	—	—	—	X	—	—	—
Taxidea taxus	X	—	—	X	X	X	X	X	—	X	—	—	—	X
Spilogale putorius	—	—	X	X	—	X	X	—	—	—	—	—	—	—
Mephitis mephitis	X	X	X	X	X	X	X	X	X	X	X	—	X	—
Conepatus mesoleucus	—	—	—	—	—	—	X	—	—	—	—	—	—	—
Lutra canadensis	—	—	X	—	—	—	—	—	—	—	—	X	—	—
Felis concolor	—	—	X	X	—	—	X	X	X	—	—	—	—	—
Lynx canadensis	—	—	—	—	—	—	—	—	—	—	X	—	—	—
Lynx rufus	—	—	X	X	X	X	X	X	X	—	X	—	—	X
Cervus canadensis	X	—	—	—	X	X	—	X	—	X	X	—	X	X
Odocoileus hemionus	—	—	X	X	X	X	X	X	X	X	X	X	X	X
Odocoileus virginianus	—	—	X	—	—	—	X	X	—	—	—	—	—	—
Antilocapra americana	X	—	—	—	X	X	—	—	—	X	—	—	—	—
Bison bison	X	—	—	—	X	—	—	—	—	X	—	—	—	X
Ovis canadensis	—	—	—	X	—	—	X	—	—	X	—	—	—	X
TOTAL	42	19	29	51	30	34	53	42	37	37	38	26	30	28
Percentage of total fauna (118 species)	36	16	25	43	25	29	45	36	31	31	32	22	25	24

In terms of life-zones, *S. tridecemlineatus* is Upper Sonoran and Transition, and, following Cary (1911: frontispiece, see Fig. 118 herein), Canadian as well, for the species occurs in South Park. In terms of biomes, quite obviously this is a grassland species, yet it occurs in small openings in ponderosa and piñon-juniper woodland and also in mountain parks. Utilizing the system of community-types outlined above, *S. tridecemlineatus* is seen to occupy—primarily or secondarily—five kinds of communities (Table 27), although its principal adaptation is to subhumid grasslands.

The ecological distribution of 118 species of resident Coloradan mammals in 14 major community-types is given in table 27. Data from which the table is constructed have been derived eclectically from general studies (for example, Cary, 1911; Warren, 1942; Lechleitner, 1969), from local faunal studies (for example, Findley and Negus, 1953; Durrant and Robinson, 1962; Blake and Blake, 1969), and from personal observation and field notes.

Categoric community-types are broadly construed and therefore heterogeneous. Species are tabulated in those community-types wherein they characteristically seek food or cover. Community-types occupied occasionally or incidentally by a given species are not indicated.

The instance of S. *tridecemlineatus* outlined above is an extreme case that points out the difficulty of such an approach. Quite obviously, subjective judgments have been made and to that extent the tabulation, like the community-types themselves, is negotiable.

Species of bats are particularly problematic under the system utilized. A number of species use caves, tunnels, mines, or buildings as roosts. Such structures have not been judged to constitute a major community-type. Species of bats have been tabulated in those communities over or through which they are known to forage. The relationship of some kinds of bats to community-types (in the present sense) may be indirect. A strong case could be made for excluding bats from the present analysis, but probably their inclusion does not greatly alter the outcome and it may be of some heuristic value.

A matrix of faunal similarity between community-types is shown in table 28. Absolute numbers of species in common are indicated below the diagonal. Bold-face numerals on the diagonal indicate total numbers of species in each community-type. An index of similarity (Faunal Resemblance Factor) is entered above the diagonal. For explanation of that index, see Table 26 and accompanying text. Obviously, the indices calculated are a function of faunal size, so that they are only roughly comparable. Quasi-mathematical analyses of the sort utilized herein are appropriate to the kinds of data presented in table 27. The greatest failing of such analyses is that they appear to be more detailed and precise than they are in fact. A proper modicum of caution must accompany any conclusion drawn from them. Despite these reservations, however, a comprehensible pattern of relationships emerges from the analysis. The mean of 91 indices tabulated is 0.4351 (standard deviation, 0.1741). In view of this, indices above about 0.600 are of particular interest.

The fauna of the subhumid grassland is not especially closely related to that of any other community-type. Its closest faunal resemblance is with sagebrush and semidesert scrub communities. Other fairly high resemblances are with saxicoline brush and mountain-meadow community types.

Plains wetlands show a single index of more than 0.400, that with plains riparian woodland. Likewise, the latter community-type has few closely related faunas. No faunal resemblance index is greater than 0.500, and those above 0.400—save plains wetlands—all are relatively mesic community-types restricted to the mountains. Both plains wetlands and plains riparian woodland are characterized by species with predominantly midcontinental distributions that find their western limits in eastern Colorado.

The saxicoline brush community-type is closely related to a number of communities, centered both on the plains and in the mountains. Its closest resemblance is to semidesert scrub and ponderosa pine woodland. The saxicoline brush community-type has the second largest fauna (see foot of Table 27) of any of the 14 categorical community-types, 51 species. The fauna of such communities is rich and heterogeneous, an ecotonal fauna transitional between communities of plains and arid valleys and communities of the foothills and mountains.

Sagebrush communities have a broad altitudinal range that is reflected in the relatively strong resemblances of the community-type to a number of others. The closest resemblance is to semidesert scrub communities, but relations to ponderosa woodland and to mountain-meadows also are strong. The high faunal resemblance to alpine meadows is in part an artifact of the small size of the latter fauna. A second factor involved is the eurye-

TABLE 28

Matrix of faunal similarity among 14 community-types.
(See text for explanation.)

Community-type	Subhumid grassland	Plains wetlands	Plains riparian woodland	Saxicoline brush	Sagebrush	Semidesert scrub	Pygmy conifer woodland	Ponderosa pine woodland	Montane forest	Montane and subalpine meadow	Subalpine forest	Highland streambank	Aspen woodland	Alpine meadow and fellfield
Subhumid grassland	**42**	.262	.200	.409	.555	.579	.298	.289	.178	.405	.225	.118	.167	.257
Plains wetlands	8	**19**	.425	.171	.204	.189	.141	.167	.250	.250	.210	.356	.286	.213
Plains riparian woodland	7	10	**28**	.354	.271	.322	.375	.464	.492	.492	.363	.444	.310	.286
Saxicoline brush	19	6	14	**51**	.444	.565	.835	.609	.477	.500	.360	.286	.444	.405
Sagebrush	20	5	8	18	**30**	.656	.439	.563	.477	.597	.470	.250	.500	.621
Semidesert scrub	22	5	10	24	21	**34**	.488	.400	.338	.451	.333	.200	.344	.387
Pygmy conifer woodland	14	5	15	43	18	26	**52**	.667	.472	.382	.425	.257	.439	.350
Ponderosa pine woodland	12	5	16	28	20	15	31	**41**	.436	.590	.608	.448	.704	.580
Montane forest	7	7	16	21	16	12	21	17	**37**	.594	.853	.571	.478	.720
Montane and subalpine meadow	16	7	16	22	20	16	17	23	22	**37**	.640	.571	.716	.738
Subalpine forest	9	6	12	16	16	12	17	24	32	24	**38**	.562	.765	.697
Highland streambank	4	8	12	11	7	6	10	15	18	18	18	**26**	.704	.519
Aspen woodland	6	7	9	18	15	11	18	25	16	24	26	19	**30**	.690
Alpine meadow and fellfield	9	5	8	16	18	12	14	20	27	24	23	14	20	**28**

SPECIES IN COMMON

FAUNAL RESEMBLANCE FACTOR

cious nature of the alpine fauna, a point of some interest discussed further below.

The semidesert scrub community-type supports a xeric-adapted mammalian fauna closely related to the fauna of sagebrush communities, and also showing a close resemblance to that of subhumid grasslands of the plains and saxicoline brush communities of foothills and other areas of broken terrain.

The pygmy-conifer woodland shows a close resemblance to saxicoline brush communities in terms of its mammalian fauna. Another strong resemblance is with ponderosa pine woodland. Sixty-eight species of mammals (57.6 per cent of the native Coloradan fauna) occur in one or more of the three foothills brush or woodland community-types. Together these communities comprise a zone truly transitional between major campestrian and highland ecofaunas. Ponderosa pine woodland is strongly related to saxicoline brushlands and piñon-juniper woodlands on the one hand, and to highland forest community-types on the other.

The six community-types on the right side of Table 28 show close mutual faunal similarities. All occur in relatively mesic situations at moderate to high elevations. Most of the community-types are rather closely related to the transitional types of the foothills. However, faunas of only two of the communities bear much resemblance to campestrian faunas. Montane and subalpine meadows and montane forest both have moderately strong relationships with plains riparian woodlands.

The closest faunal resemblance between any two community-types in table 28 (0.853) unites montane and subalpine forests. Aspen woodland shows strong ties with both montane and subalpine meadows and also with coniferous forest community-types. The strong relationship with meadowlands suggests an observation that is obvious in the field. To many mammalian species, aspen woodland must represent a simple meadow. The presence of broadleafed deciduous trees is irrelevant to their occupancy of the community-type save as standing trees and abundant windfalls increase available cover, and partial shade from the tree synusia, encourages rank growth of herbs.

Alpine meadow and fellfield shows a strong faunal resemblance to each of the other community-types characteristic of the mountains. Resemblances to several more mesic community-types of lower elevations also are not far below the mean index in the matrix. The alpine fauna is a derived assemblage in that no species is restricted there. A considerable proportion of the alpine fauna (25 species, 89.3 per cent of the fauna) occurs in six or more community-types as defined herein. Characteristic alpine mammals such as the pika (*Ochotona princeps*) find optimal cover in the alpine zone, but range to considerably lower elevations under suitable circumstances.

Thirty species (25.4 per cent) of Coloradan mammals are sufficiently euryecious to be tabulated in six or more community-types. The six species ranging through 12 community-types must be considered essentially ubiquitous although, of course, habitat preference still is important at finer levels of ecological resolution. Such widespread species are: *Peromyscus maniculatus, Canis latrans, Ursus arctos, Mustela frenata, Mephitis mephitis,* and *Odocoileus hemionus.* Three other species (*Lepus townsendii, Eutamias minimus, Thomomys talpoides*) range through 11 community-types. Most Coloradan mammals are more narrowly restricted in range of communities occupied. Fifty-three species (45.9 per cent of the fauna) occur in only one or two community-types. Eighty-eight species occur in five communities or fewer.

Of the 21 species restricted in Colorado to a single community-type, nine occur on subhumid grasslands, and seven occur in mesic campestrian situations. A single species (*Conepatus mesoleucus*) occurs only in piñon-juniper woodlands, two (*Sciurus aberti* and *Microtus mexicanus*) occupy ponderosa pine woodlands, and two (*Gulo gulo* and *Lynx canadensis*) occur only in dense subalpine forests. Possibly the tabulation of some of there extremely stenoecious kinds is too conservative. The status of some of the species in Colorado is poorly known.

An elementary cluster analysis (Fig. 119) in the form of a simple "phenogram" is based on indices of faunal resemblance, and constructed by the "weighted pair-group method" of Sokal and Sneath (1963:309). While the figure represents a considerable loss of information over the similarity matrix from which it is derived (Table 28), certain of the broad relationships between community-types noted above are readily apparent.

The distinctive character of the mesic-adapted community-types of the plains is strikingly illustrated by the analysis. Xeric-adapted faunas of foothills and valleys are seen to be strongly inter-related, on the one hand, and to resemble strongly the fauna of the plains on the other. Community-types of the mountains cluster as those dominated by coniferous forest and those in which herb synusiae are of predominant importance.

Brief comparison is warranted between the foregoing analysis by community-types and the classical life-zone system outlined in the preceding section. The heterogeneous nature of the Upper Sonoran Zone has been pointed out previously. That point is emphasized by the present analysis. Seven of the

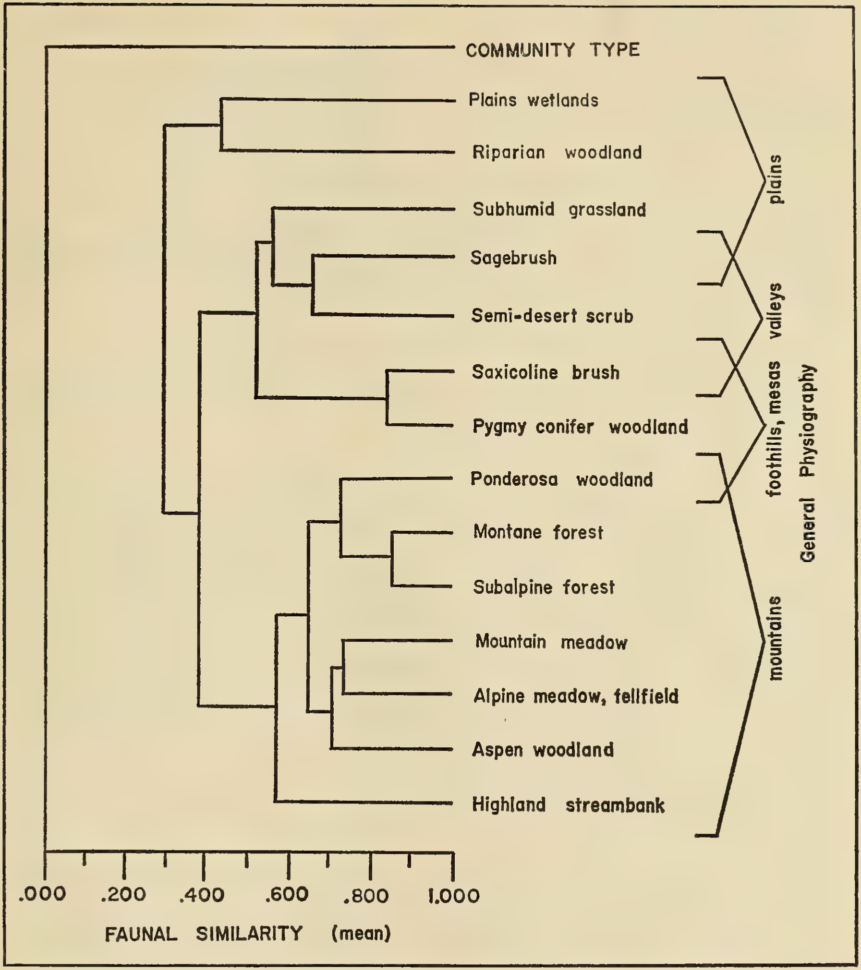


FIG. 119. Similarity phenogram of 14 Coloradan community-types; for explanation, see text (also see Table 28).

14 community-types tabulated are subsumed in the Upper Sonoran Zone of Cary (1911). Five of those (subhumid grassland and communities of foothills and valleys) exhibit a generally strong mutual resemblance. However, mesic communities of the plains are not at all closely related to other "Upper Sonoran" community-types, and are not particularly strongly related to each other.

Whereas the classical Upper Sonoran Zone appears to be overly inclusive in the light of this analysis, life-zones of higher elevations seem to be too finely divided. Considerably greater faunal similarity is evidenced among the seven highland community-types, which correspond roughly to four life-zones, than is seen within the community-types of the Upper Sonoran Zone. Part of the similarity of the upper zones derives from the fact that certain community-types as defined by me overlap at least three life-zones. However, the closest similarity among any three community-types is within the triad of coniferous forest communities, which correspond rather closely to three distinct life-zones, Transition, Canadian, and Hudsonian.

Species Density

Species density is defined as the number of species present per unit-area. Species diversity, on the other hand, is a measure of the relative density of species in ecological units. When the unit-areas considered correspond to ecological units, comparison of species densities may allow assessment of faunal diversity. Species density is a simple notion, whereas species diversity is a complex ecological and evolutionary problem. When units of analysis are arbitrary subdivisions of an area, species diversity and species density are quite different considerations and ought to be distinguished carefully.

To analyze species density within Colorado, a grid of 70 quadrats was constructed. Quadrats were nearly square (39.4 by 38.7 miles), and approximately 1525 square miles in area. For purposes of tabulation, the grid was aligned with an axis perpendicular to the southern boundary of the state at its midpoint. Known biotic and physiographic units were neither selected nor avoided, but simply ignored. Use of a rectilinear grid over a map of Colorado means that the area within the state of marginal quadrats is variable. Distortion of the tabulation was avoided by projecting ranges into adjacent states. A species was considered to occupy a given quadrat if one-half or more of the quadrat was occupied.

Distributions of 100 species were tabulated. The 18 resident species excluded were those too narrowly distributed to occupy one-half of any quadrat (*Blarina brevicauda, Microtus mexicanus*), and those too poorly known to allow the range to be outlined with any degree of confidence. Of the 16 species that I considered too poorly known to tabulate, two (*Didelphis marsupialis, Lasiurus borealis*) are of eastern distribution, five occupy mountain and foothills communities, and nine are widespread over the state, although present or historic boundaries of ranges are uncertain.

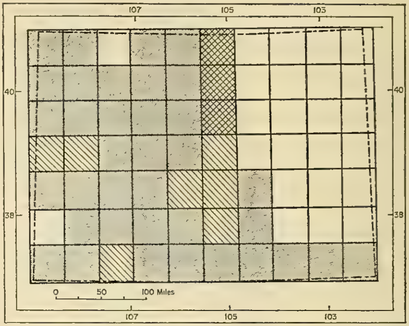


FIG. 120. Absolute species density of mammals in Colorado. Legend: 60 species or more, cross-hatched; 50 to 59, diagonal lines; 40 to 49, stippled; 39 or fewer, unshaded. For description of grid, see text.

Absolute species density of mammalian species in each of the 70 quadrats is given in figure 120. The mean density is 43.6 species per quadrat (range, 32 to 63, standard deviation, 7.054). A three-dimensional graph of species density over the area of the grid is shown in figure 121; curves were fitted to points by eye.

The sixth column in figure 120 exhibits densities that are consistently high. That column overlies the Front Range and other eastern ranges. Within the area covered occur some of the most abrupt changes in elevation in the state (see Marr, 1961 and Rodeck, 1964). Species characteristic of the plains and mountains combine with the diverse, specialized assemblage characteristic of the foothills to produce the observed density.

Densities above 50 species per quadrat overlie the lower Grand Valley (D-1, D-2) and part of the San Juan drainage. Both of

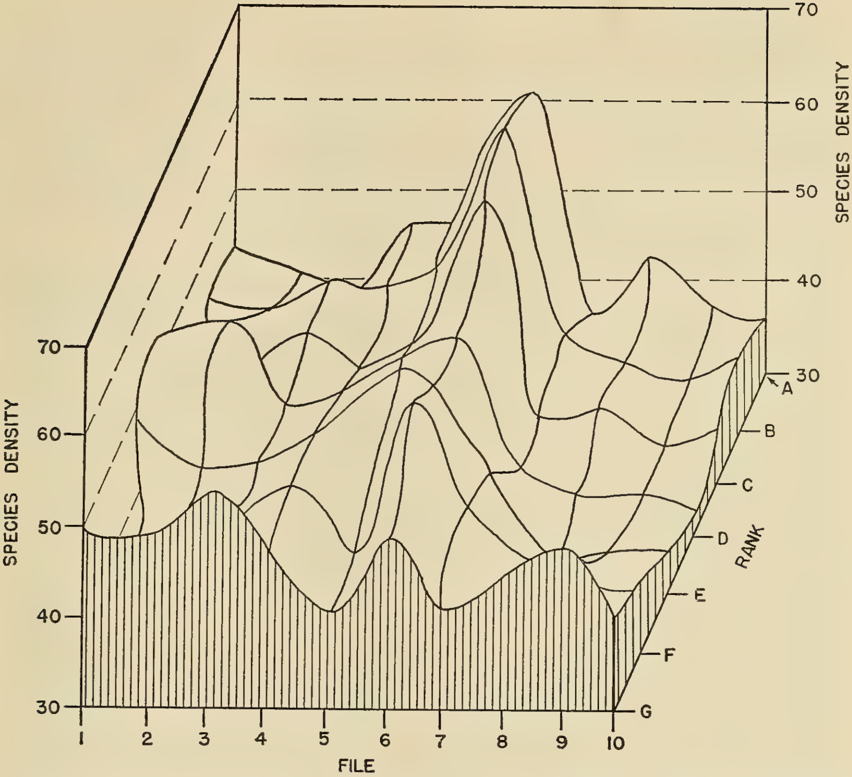


Fig. 121. Three-dimensional graph of absolute species density of mammals in Colorado (for explanation, see text).

these are areas in which eremican and highland species are in close proximity because of topographic (hence, ecological) complexity.

Densities above the average are prevalent over most quadrats covering central and western Colorado. (Low values in quadrats A-3 and F-1 probably are artifacts of inadequate knowledge of the faunas of those areas). In addition, rather high densities occur eastward along the southern margin of the grid, corresponding to the broken terrain of the Raton Section.

Consistently low densities occur over the eastern plains. A single near-average quadrat (A-8) corresponds to the Pawnee Buttes area. All other quadrats over the plains include 40 species or fewer. Quadrats F-5 and G-5 also show low densities. Those units overlie the San Luis Valley.

The rather striking resemblance of some areas of Fig. 121 to a crude physiographic block diagram is a function of the fact that a complex of diverse ecological associations accompanies rapid altitudinal change. In general, individual community-types at higher elevations include fewer species than those at intermediate elevations (Table 27). The close proximity of community-types in areas of high relief is responsible for high densities in quadrats centered over such areas.

Simpson (1964) studied species density in North American mammals, utilizing a grid of 150-mile square quadrats. He pointed out (*op. cit.*:68) that an abrupt westward increase from 70 to 107 species per quadrat occurred in adjacent units superimposed over eastern Colorado. Simpson (*op. cit.*:69) concluded that topographic increases in species density are connected with high relief and not with mountains or altitude as such. Certainly that conclusion is substantiated herein at the present level of resolution. Areas of high relief offer more varied ecological opportunity than those with more monotonous terrain. Distinctive communities comprised of comparably adapted (or adaptive) species respond to that ecological opportunity. Competition (in a broad sense) tends to apportion the available environment among the communities, limiting each to optimal situations. This leads to finely divided resources and to high species densities per arbitrary unit-area.

A trend of increasing species density toward the equator is to be seen in many groups of organisms. Among North American mammals, a general—sometimes dramatic—increase in numbers of species is seen from north to south (see Simpson, 1964:61). However, between latitude 30° and 50° north, the pattern is not discernible. Within the United States as a whole, other trends (especially east-west gradients and topographic patterns) obscure any such north-south gradient. Certainly that is the case in Colorado. The attenuation or truncation of distributions of both northern and southern elements within the state precludes the establishment of any north-south trend in species density.

The diversity of mutually dependent species within a given ecological unit is a complex question, the evolutionary and ecological bases of which remain speculative (Udvardy, 1969:293). Species density per unit-area is, in the main, an index of gross environmental complexity, in part reflecting diversity within the area.

ECOGEOGRAPHIC DISTRIBUTION

The most cursory study of mapped ranges of species reveals that certain broad patterns tend to repeat themselves. That fact has led to a number of attempts to formalize recurrent patterns in systems of geographic and ecogeographic units. Entry to the abundant literature on the subject is provided by Hagmeier and Stults (1964) and Udvardy (1969), among others, and no thorough review is offered here.

Mammalian distributional areas are herein defined as geographic entities characterized by a relatively homogeneous mammalian fauna and separated from other such entities by zones of heterogeneity (after Hagmeier and Stults, 1964:125). Inasmuch as areal and biotic factors are inherent in their definition, mammalian distributional areas are, like biotic provinces, ecogeographic units. Dice (1952:444) viewed biotic provinces as centers of ecological dispersal. Unlike biomes and classical life-zones, biotic provinces are continuous areas and generally evince a distinctive evolutionary role and history, particularly at finer levels of taxonomic resolution.

According to Dice (1943:3) a biotic province ". . . covers a considerable and continuous geographic area and is characterized by the occurrence of one or more important ecologic associations that differ, at least in proportional area covered, from the associations of adjacent provinces. In general, biotic provinces are characterized also by peculiarities of vegetation type, ecologic climax, flora, fauna, climate, physiography, and soil." Horizontal subdivisions of biotic provinces are termed "biotic districts," vertical subdivisions, "life belts."

Boundaries of biotic provinces may follow obvious physiographic barriers. Sometimes, however, no obvious barrier intervenes, the distinctiveness of adjacent provinces being the result of subtle climatic changes. Thus, seemingly arbitrary boundaries sometimes are necessary (Dice, *op. cit.*:445).

Dice (1943) mapped biotic provinces of North America and discussed the individual provinces in some detail. Because of the interest of the notion of ecogeographic units, the concept has been widely discussed and applied. In the process, however, there has been a tendency to distort the original broad definition of provinces to make them faunistic units, typically based on a narrow range of taxa. Axtell (1962) assessed trends in the use of the concept of the biotic province.

A faunistic study such as the present one can in no sense define biotic provinces within its restricted perview. On the other hand, an ecogeographic survey of mammalian distributional areas is of some interest. Faunal areas correspond broadly with biotic provinces, their subdivisions, and aggregates thereof. It is from a compilation of such faunal areas, each based on detailed study of a workable segment of the biota, that accurate knowledge of biotic provinces eventually will be gained.

Probably the earliest method devised by faunists to outline natural distributional units was the superimposition of ranges of taxa. In some ways this remains the most satisfactory method of analysis, particularly in instances where maps of relatively great accuracy are available and limits of species (or other taxonomic units) are generally well known. This is the case as regards mammalian species over much of North America.

Limits to distribution are species-specific. A given environmental feature or historical event is of differential importance as a barrier to various members of the fauna. Generally speaking we may recognize three kinds of distributional limits—historical, physical, and ecological.

Historical limits are seen as actively expanding or contracting fronts, not yet defined by any ecological or physical barrier. Documented on-going changes in range characterize such Coloradan mammals as *Didelphis marsupialis, Lepus californicus, Spermophilus richardsonii, Sciurus niger*, and *Procyon lotor.* Some of the observed dynamism stems from cultural changes in ecological conditions (for example, alterations in the extent of mesic communities with irrigation). In other cases, slight climatic change may be important. In still other instances, internal pressures of population growth, triggered perhaps by subtle ecological change, may underlie a patent dynamism in the apparent absence of any change in habitat.

Physical barriers may include rivers, cliffs, canyons, and other such features. Over much of its length, the Colorado River and its canyons form an important physical barrier (see, for example, Goldman, 1937; Kelson, 1951a; Durrant, 1952). However, the physical presence of a physiographic feature seldom is as important as its ecological consequences. Barriers that are ultimately physical frequently are proximally ecological. The Grand Valley of the Colorado is an important barrier to the distribution of highland mammals. However, it is neither the presence of more than 3000 feet of relief in the area, nor the presence of a large, permanent stream, that precludes forest-adapted mammals from crossing at will. It is the occurrence on the floor and sides of the valley of semidesert vegetation that constitutes the barrier. The principle of this obvious example applies in more subtle cases as well.

Rivers in much of central and western Colorado are headwater streams and are of only moderate effectiveness as direct or indirect barriers. Major canyons (Ladore Canyon of the Green, Black Canyon of the Gunnison, Royal Gorge of the Arkansas) may be of local importance to some species, but as a rule are far less effective than patently ecological barriers in shaping the distributions of Coloradan mammals. On the eastern plains, rivers are of markedly less importance as ecological or physical barriers to distribution than are the divides between them.

Ecological limits are those most frequently seen in mature patterns of distribution, and locally they must effect all species. In fact, limits distinguished as historical and physical are really ecological limits in a broad sense. An ecological limit may consist of the boundary of a community-type or the ranges of other species of mammals.

The occurrence of allopatric or parapatric species may indicate direct competitive exclusion or differential response to ecological conditions. A number of instances of allopatry between species have been described (*Sylvilagus floridanus* and *S. nuttalii, Eutamias quadrivittatus* and *E. umbrinus, Spermophilus richardsonii* and *S. spilosoma,* and species of the genus *Cynomys* and of the family Geomyidae). In general, relationships involved in these instances of complementary

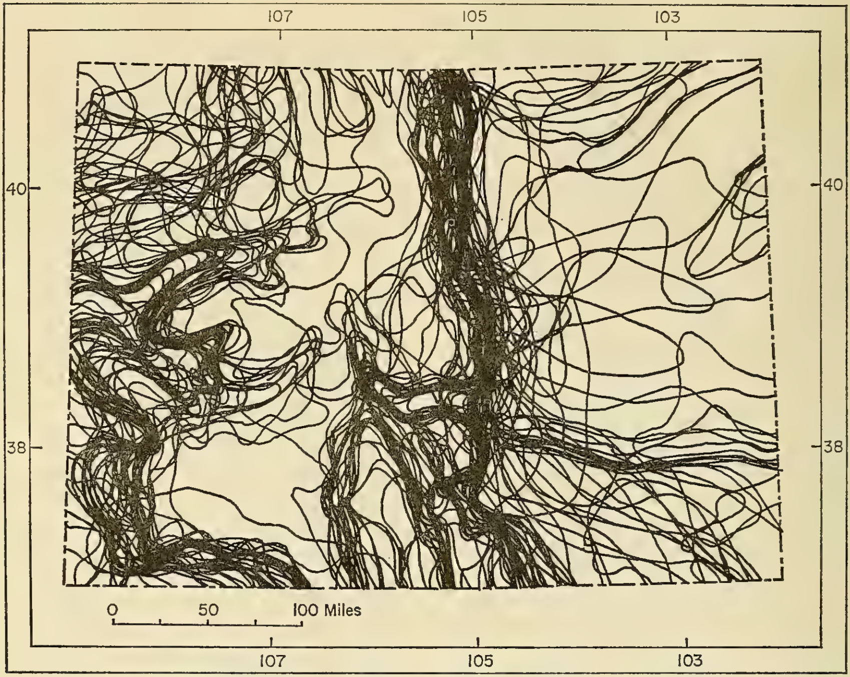


FIG. 122. Superimposed Coloradan limits of 88 species of mammals.

distribution have been inadequately studied and causative models are lacking.

Most frequently, distributional limits in Colorado coincide with boundaries of major ecological community-types. As stressed previously, the best illustrations of this fact are observable in areas of abrupt relief. Throughout the state, however, the interaction of a diverse and demanding environment and a specialized mammalian fauna produces striking coincidence of distributional limits.

A superimposition of limits of ranges of 88 native species of Coloradan mammals is shown in figure 122. Excluded from the compilation are 13 species for which data are inadequate to allow the range within the state to be outlined with any confidence, three species of only occasional occurrence, and 17 species that range essentially throughout the state. It is quite possible to recognize on such a map areas of natural distribution separated by zones of rapid faunal change. Most workers have returned, as I shall, to such diagrams to refine boundaries of distributional areas defined by numerical or other methods.

It should be obvious that to reason from outline distributions to natural areas is in part a circular argument. Not all marginal localities are known. Were most or all such localities represented among records of a given species, one still would have to qualify a boundary in terms of time. In the field, most "boundaries" of ranges are in fact dynamic fronts, responding to immediate ecological opportunity with expansion or contraction. Any mapped boundary (at the scale herein utilized) represents an educated guess. Included in that estimate are the known ecological preferences of species and the distribution of suitable habitats. The boundary of a species as mapped, then, depends to a greater or lesser degree on the known limits of ecological units. When boundaries drafted on this basis are utilized, in turn, to define natural areas, circularity is complete. Nonetheless, the fallacy, however obvious, is of minimal biogeographic importance. Boundaries of ranges of species, where known in detail, do coincide with boundaries of major community-types, biomes, and other such ecological units. The coincidence of a number of boundaries in a narrow zone suggests a barrier of considerable strength. Numerical analysis reveals relative strengths of such barriers.

Hagmeier and Stults (1964) analyzed occurrence of limits of mammalian species over North America north of Mexico. Their method was utilized to quantify coincidence of limits in Colorado. A grid of 70 quadrats was superimposed over each of 88 species range maps and a tabulation made of the number of limits per quadrat (for description of the grid, see the preceding discussion of species density). An index of faunal change was calculated for each quadrat (IFC = 100 L/n, where *L* equals the number of species at their limit within a given quadrat, and *n* equals the total number of species in the quadrat—after Hagmeier and Stults, 1964: 130). The mean of the 70 IFC values is 40.47 (range, 3.1 to 96.1, standard deviation, 25.142). For a graphic presentation of IFC values over the grid, see figure 123. Broad agreement is obvious between the qualitative data of figure 122 and its quantification in figure 123.

Other quantitative methods are concerned more directly with areas of occurrence than with limits of ranges. Huheey (1965) calculated a faunal divergence factor in analyzing the distribution of the herpetofauna of Illinois. The formula, $\text{FDF} = N_a + N_b / N_a + N_b + N_c$ (where N_a is the number of species present only in one of two adjacent areas, N_b is the number of species present only in the other, and N_c is the number of species occurring in common), was calculated for

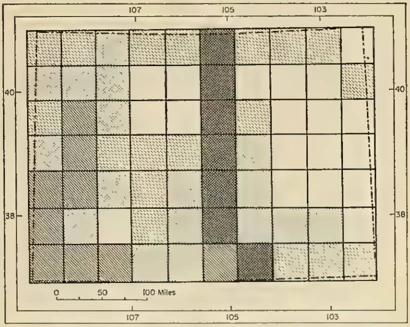


FIG. 123. Distribution in Colorado of index of faunal change, a measure of coincidence of limits of species (for explanation, see text). Legend: IFC 80 or greater, cross-hatched; 60 to 79, solid diagonal lines; 40 to 59, stippled; 20 to 39, broken diagonal lines; 0 to 19, unshaded.

each pair of contiguous quadrats. The average of factors relating a given quadrat with each of its neighbors was taken to be the index for that area. Iso-lines termed "isometabases" were drawn connecting areas of equal faunal divergence. Lines of high divergence were recognized as barriers, whereas areas of low divergence were seen to be natural areas. The mathematical scheme gave results in Illinois comparable to the graphic methods of P. W. Smith (1961:11).

Applied to Coloradan mammals, at a level of resolution allowed by present knowledge of the fauna, the above method was found to be inadequate. Principal ecological barriers to mammalian distribution in Colorado are oriented north to south, with secondary barriers (especially drainage systems) oriented mostly east to west. To average the strong east-west divergence along the mountain front with the weak north-south divergence along the western margin of the plains tends to "smooth out" a trend surface that, in fact, has high relief. Such problems were recurrent in the direct application of the method of Huheey (1965) to Coloradan mammals.

Ryan (1963) modified slightly the analytic method of Webb (1950) to delineate "biotic provinces" in Central America. A similarity value, $\text{SV} = 100\ C / N_1 + N_2 - C$ (where

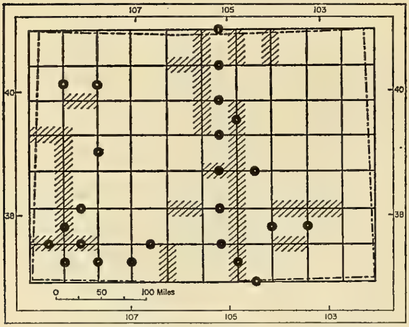


FIG. 124. Incidence of zones of rapid faunal change in Colorado. Legend: shaded lines, FDF greater than mean plus one standard deviation; dots, SV less than mean minus one standard deviation. For explanation of indices, see text.

N_1 is the number of species in the first area, N_2 the number in the second, and C the number of species in common), was applied to each pair of sample points over the grid. Iso-lines were drawn connecting points of equal SV. Major biotic associations were recognized by the presence of areas of high SV separated by barriers marked by low SV. Prominent physiographic features coinciding with zones of low SV were selected as boundaries for provinces.

In attempting to determine important mammalian distributional units in Colorado, a combination of the Webb-Ryan method (after Ryan, 1963) and the method of Huheey (1965) was employed. Values of the FDF (of Huheey) were calculated for adjacent quadrats over the grid described previously. A species was admitted to occur in a given quadrat if one-half or more of the area of the quadrat was occupied. Fractions of quadrats were estimated by eye.

The mean of FDF's on the east-west gradient was 0.3371 (range, 0.000 to 0.761, standard deviation, 0.2256). The mean of FDF's on the north-south gradient was 0.2748 (range, 0.032 to 0.521, standard deviation, 0.1333). FDF's were plotted on appropriate lines of the grid. Lines bearing values equal to or greater than the mean plus one standard deviation were cross-hatched (Fig. 124).

Similarity values (SV of Ryan, 1963) were calculated for each pair of sample points. Sample points were the 88 points of intersection of the grid of 70 quadrats used previously. The mean SV on the east-west gradient was 69.93 (range, 5.1 to 97.1, standard deviation, 22.643). The mean SV on the north-south gradient was 73.61 (range, 27.6 to 100.0, standard deviation, 14.619). SV's were plotted on appropriate lines of the grid. All values smaller than the mean less one standard deviation were designated by a dot (Fig. 124).

Areas of high faunal divergence (FDF) or low faunal similarity (SV) are zones of rapid faunal change corresponding to major barriers to dispersal. Superimposing results of the two analyses serves to check one against the other. In addition, the size of units of analysis is essentially halved, inasmuch as one method utilized point-occurrence of taxa, and the other utilized occurrence of the same taxa over an area. The presence of low SV's and high FDF's over the area of the grid is shown in figure 124.

To arrive at tentative mammalian distributional areas, the above analytic results were coupled with the map of superimposed ranges (Fig. 122), and the known occurrence of major barriers. The approximate limits of mammalian distributional areas in Colorado are shown in figure 125.

The nomenclature of faunal distributional areas has been approached in a number of ways. Hagmeier and Stults (1964) named "mammal provinces" to correspond with biotic provinces. I follow the practice of Durrant (1952:481) in adopting a system of names based on physiographic and hydrographic units. This avoids possible confusion between mammalian distributional areas and biotic provinces, yet utilizes a standard and readily understood terminology. Mammalian distributional areas of Colorado are:

- Rocky Mountain Faunal Area
    - San Luis Valley Faunal District
- Wyoming Basin Faunal Area
- Great Plains Faunal Area
    - Northern High Plains Faunal District
    - South Platte Valley Faunal District
    - Arkansas Valley Faunal District
    - Raton Faunal District

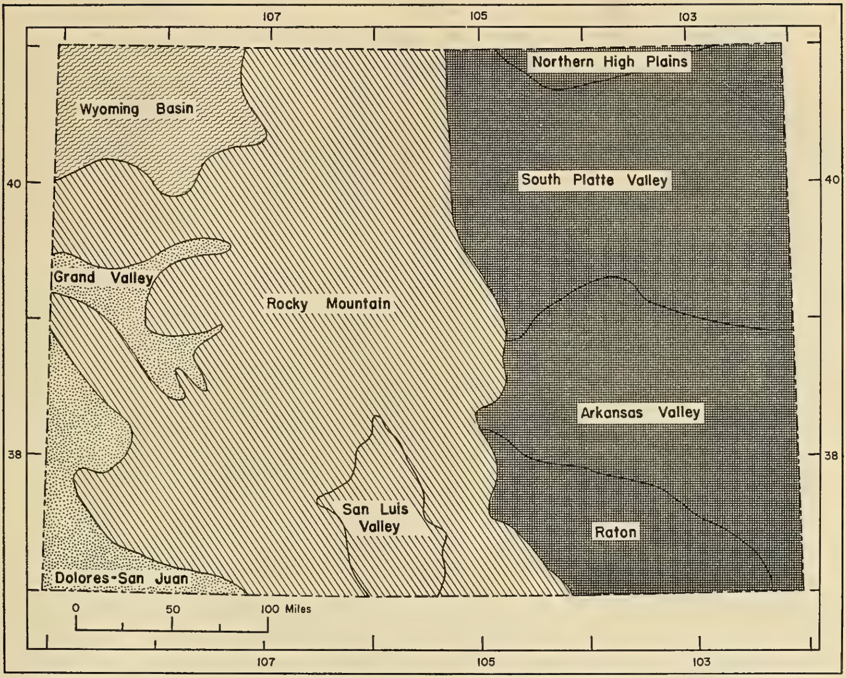


FIG. 125. Mammalian distributional areas of Colorado.

Colorado Plateau Faunal Area
Grand Valley Faunal District
Dolores-San Juan Faunal District

The above distributional areas relate in a general way with comparable mammalian faunal divisions in Utah (Durrant, 1952:480), Kansas (Cockrum, 1952:15), Nebraska (Jones, 1964:46), and Wyoming (Long, 1965:725). Correspondence between areas in Colorado and those in adjacent states is sufficiently close that no synonymy is considered necessary. Comment is in order, however, on units recognized in adjacent states but not in Colorado. Durrant (1952:480) mapped seven distributional units along the eastern boundary of Utah. The unit herein called the Wyoming Basin Faunal Area corresponds to three units in Utah. The Uinta Mountain Province (of Durrant) might prove recognizable in Colorado west of the Green River with further knowledge of mammals of that area. No other subdivision in northwestern Colorado is indicated. The Uinta Mountains separate distinctive faunal units in northeastern Utah, but there is no comparable barrier to distribution in northwestern Colorado.

The area of the Tavaputs Plateau in eastern Utah was considered by Durrant to represent a subcenter of the Northern Great Plains Faunal Area. The Roan Plateau in western Colorado is, however, considered by me as a westward extension of the Rocky Mountain Faunal Area. There is a gradual attrition westward of highland species from the White River Plateau to the Roan and Tavaputs plateaus. The most obvious ecologic break

TABLE 29

Similarity matrix of mammalian distributional areas at specific level. (For explanation, see text.)

	Mammalian Distributional Area	Wyoming Basin	Northern High Plains	South Platte Valley	Arkansas Valley	Rocky Moun-tain	Grand Valley	Dolores-San Juan	San Luis Valley	Raton	
	Wyoming Basin	26	.290	.204	.155	.134	.432	.364	.344	.256	
	Northern High Plains	9	14	.400	.379	.068	.138	.167	.347	.241	
Species in Common	South Platte Valley	9	12	28	.687	.016	.145	.192	.285	.214	Coefficient of Community
	Arkansas Valley	7	11	22	26	.017	.152	.200	.303	.256	
	Rocky Mountain	7	3	1	1	33	.071	.114	.111	.037	
	Grand Valley	16	5	7	7	4	27	.694	.222	.470	
	Dolores-San Juan	16	7	10	10	6	25	34	.307	.583	
	San Luis Valley	11	8	10	10	5	8	12	17	.212	
	Raton	10	7	9	10	2	16	21	7	23	

in this corridor is in the vicinity of the Grand Hogback. However, a number of highland kinds occur west of that gap at least to Douglas Pass. I choose to emphasize the obvious mammalogical relationship of the area to the highland core of the state.

The area south and east of the Colorado River in southeastern Utah was subdivided by Durrant into two subcenters. Some argument could be made for the separation of Dolores and San Juan watersheds as distinct units in Colorado, but even at the subspecific level, such units would be closely related.

The occurrence of 88 species of native mammals in each of the nine distributional units in Colorado was tabulated. A species was said to occur in a given area if it occurred over one-half or more of that area, or if one-half or more of its range in Colorado occurred in that area, a protocol suggested by Hagmeier and Stults (1964:132). Fractions of ranges were estimated by eye. Omitted from the tabulation were species too poorly known to tabulate accurately, and those ranging throughout all nine distributional areas.

A similarity matrix at the specific level was constructed for the nine distributional areas (Table 29). Absolute numbers of species in the areas appear along the diagonal. Absolute numbers in common appear below the diagonal. Above the diagonal is entered a coefficient of community (after Simpson, 1960:300), analogous to the similarity value of Ryan (1963) utilized above. Coefficients of community were subjected to elementary cluster analysis by the "weighted pair-group method" of Sokal and Sneath (1963:309) and resulted in a similarity phenogram (Fig. 126a).

As a refinement, mammalian distributional areas were compared at the subspecific level, utilizing a method analogous to that outlined above. One hundred ninety-three native taxa (subspecies and monotypic species) were tabulated. Omitted were 17 taxa too poorly known or too generally distributed to be of use. A similarity matrix of mammalian distributional areas at the subspecific level is given in table 30. Entries are arranged as in the analogous matrix at the specific level (Table

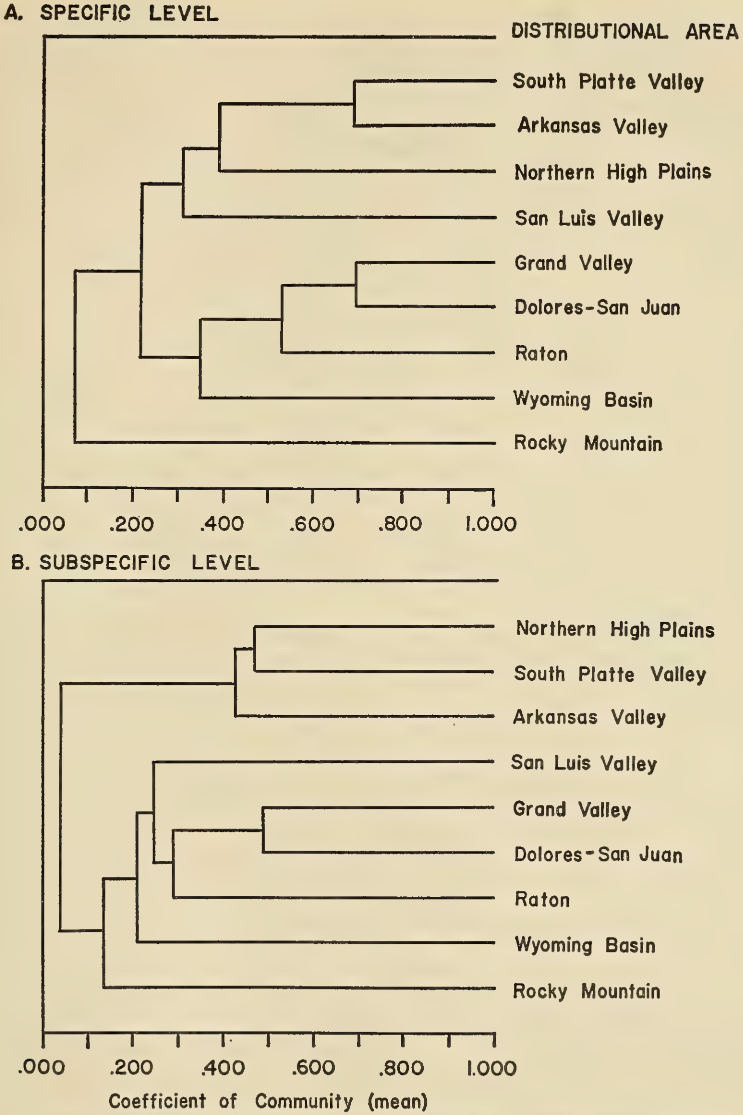


Fig. 126. Similarity phenograms of mammalian distributional areas in Colorado, based on coefficients of community. A, specific level; B, subspecific level (for explanation, see text).

TABLE 30

Similarity matrix of mammalian distributional areas at subspecific level. (For explanation, see text.)

Mammalian Distributional Area	Wyoming Basin	Northern High Plains	South Platte Valley	Arkansas Valley	Rocky Mountain	Grand Valley	Dolores-San Juan	San Luis Valley	Raton
Wyoming Basin	41	.064	.051	.042	.193	.339	.236	.213	.210
Northern High Plains	4	25	.467	.405	.024	.000	.028	.000	.091
South Platte Valley	4	21	41	.442	.031	.000	.000	.000	.136
Arkansas Valley	3	17	23	34	.011	.000	.012	.013	.222
Rocky Mountain	16	2	3	1	58	.129	.104	.167	.082
Grand Valley	20	0	0	0	11	38	.483	.268	.180
Dolores-San Juan	17	2	0	1	10	28	48	.246	.206
San Luis Valley	13	0	0	1	13	15	16	33	.241
Raton	13	9	9	12	7	11	14	13	34

Taxa in Common

Coefficient of Community

29). A cluster analysis of coefficients of community between mammalian distributional areas at the subspecific level is shown in figure 126b.

Rocky Mountain Faunal Area

The Rocky Mountain Faunal Area occupies the highlands of central Colorado. The mammalian fauna of the area is large and generally is quite distinct from that of adjacent areas at both specific and subspecific levels (Fig. 126). As is characteristic of mountainous areas in general, zonation of mammalian associations is prevalent. Zonation was discussed as an aspect of ecological distribution and is not detailed further here.

Although some highland community-types (for example, alpine situations, see figures 5 and 118) exhibit an insular pattern of distribution, mountainous areas generally are continuous or nearly so. Isolated ranges are not present to the extent that they are to the south and west of Colorado. For example, the Wet Mountains are isolated from the Sangre de Cristo Range by the Wet Mountain Valley and Huerfano Park, and from the Pikes Peak massif by the Arkansas Valley. The mammalian fauna of the Wet Mountains, while incompletely known, appears to be the same as that of the Sangre de Cristos (although the pika, *Ochotona princeps,* may be absent and the marmot there is recognized as a distinct subspecies, *Marmota flaviventris notioros*).

In western Colorado, high plateaus and independent laccolithic ranges extend the highland fauna well westward from the mountain core. The Elkhead Mountains bear a relationship to the Park Range comparable to that of the Wet Mountains to the Sangre de Cristos. The White River uplift supports virtually the entire complement of highland mammals in the state. Westward from Grand Hogback the highland fauna shows a gradual attrition, but such mesic-adapted kinds as *Sorex vagrans, Sorex palustris, Clethrionomys gapperi,* and *Microtus longicaudus* occur in the vicinity of Douglas Pass, near the Utah boundary. Grand and Battlement mesas are essentially continuous with the Elk and West Elk mountains, and their fauna represents the complete highland assemblage.

The Uncompahgre Plateau, like the Roan Plateau, provides a boreal corridor, at places quite narrow, westward to the boundary of Utah. Montane and subalpine shrews, voles, and other kinds find suitable habitat along this corridor, and some (*Zapus princeps, Microtus montanus, Microtus longicaudus*) occur across Unaweep Canyon on the hills above Glade Park. A similar fauna exists in semi-isolation on the La Sal Mountains, Utah.

In the southwestern part of the state, Mesa Verde and Ute Peak support parts of the highland fauna of the nearby mountains (*Sorex vagrans* but not *Sorex cinereus;* both *Microtus longicaudus* and *Microtus montanus,* but neither *Phenacomys intermedius* nor *Clethrionomys gapperi*). These uplifts are the only good examples in Colorado of insular distribution in isolated montane situations, such as was detailed by Lee (1960) in Utah and Findley (1969) in New Mexico. Mesa Verde and Ute Peak are mapped within the Dolores-San Juan Faunal District, inasmuch as they are generally surrounded by the area of that xeric-adapted fauna.

Mammalian species restricted in Colorado to the Rocky Mountain Faunal Area are:

Sorex vagrans
Sorex palustris
Microsorex hoyi
Ochotona princeps
Lepus americanus
Eutamias umbrinus
Tamiasciurus hudsonicus
Clethrionomys gapperi
Phenacomys intermedius
Microtus montanus
Microtus longicaudus
Zapus princeps
Martes americana
Gulo gulo
Lynx canadensis

Within the Rocky Mountain Faunal Area some differentiation is noticeable, but nowhere is it sufficient to warrant formal recognition. A cogent argument could perhaps have been mustered for division of the faunal area by a broad line connecting the upper Arkansas and Gunnison rivers. This line marks the approximate southern limit of such obviously northern taxa as *Spermophilus richardsonii* and *Eutamias umbrinus,* and the northern limit of *Eutamias quadrivittatus* as a truly montane form. Furthermore, subspeciation in *Clethrionomys gapperi, Microtus montanus,* and *Microtus pennsylvanicus* has occurred along this line. The line seems to me to reflect important historical forces of which more is said beyond. Enough patterns run counter to the limit, however, to minimize its value in any formal usage.

The Sangre de Cristo Range is distinct from other ranges in the apparent absence of *Sorex cinereus* and *Microtus montanus,* and in the presence of distinctive subspecies of *Ochotona princeps* and *Marmota flaviventris.* As mentioned previously, a nominal race of marmot, *Marmota flaviventris notioros,* distinguishes the Wet Mountains.

The subspecies *Lepus townsendii townsendii* and *Lepus townsendii campanius* intergrade along the Continental Divide as do *Eutamias minimus consobrinus* and *Eutamias minimus operarius.* The upper Gunnison and Arkansas Valleys mark the boundary between *Clethrionomys gapperi galei* and *Clethrionomys gapperi gauti.* The Upper Arkansas Valley delimits the ranges of *Microtus pennsylvanicus uligocola* and *Microtus pennsylvanicus modestus,* and also those of *Microtus montanus nanus* and *Microtus montanus fusus.*

Subspeciation in the pika shows a pattern linking the highlands of northwestern and west-central Colorado (*Ochotona princeps figginsi*), uniting the Front and Sawatch ranges with the San Juans (*O. p. saxatilis*), and isolating the Sangre de Cristos (*O. p. incana*).

Thomomys talpoides exhibits a more complex pattern of differentiation, with distinctive named kinds in the eastern ranges (*rostralis*), the San Juans and west-central Colorado (*fossor*), and on the White River Plateau and Gore, Park, and Rabbit Ears ranges (*meritus*). Such diverse patterns of differentiation make subdivision of the Rocky Mountain Faunal Area unsatisfactory.

The distinctiveness of the Rocky Mountain Faunal Area is apparent (Fig. 126). At the specific level, the average coefficient of community to other faunal units is only 0.071, and at the subspecific level the fauna relates to units of the western part of the state at 0.135. The closest resemblances (see tables 29 and 30) are with the Wyoming Basin and Dolores-San Juan faunal areas at the specific level, and with the Wyoming Basin and San Luis Valley at the subspecific level.

The San Luis Valley Faunal District is the center in Colorado of the highest degree of endemicity. No species is confined in Colorado to the district, but seven subspecies are possibly endemic there: *Eutamias minimus caryi, Spermophilus tridecemlineatus blanca, Perognathus flavus sanluisi, Perognathus apache relictus, Dipodomys ordii montanus, Thomomys bottae pervagus,* and *Thomomys talpoides agrestis.*

The San Luis Valley is included in the Rocky Mountain Faunal Area on the basis of geographic relationships. Closest faunal resemblances are with the Great Plains at the specific level and with lower-elevation districts of the Western Slope at the subspecific level. The fauna of the valley is strongly isolated from comparable associations elsewhere in Colorado by mountains. Access to the valley today by xeric-adapted kinds is via the Rio Grande Valley, species of the Great Plains moving south of the Sangre de Cristo Range in New Mexico, and those from the Colorado Plateau moving south of the San Juan and Jemez mountains. The Rio Grande Valley of northern New Mexico is today a suboptimal corridor for the open-country species that characterize the San Luis Valley.

Mapped within the Rocky Mountain Faunal Area (Fig. 125) are enclaves of faunal units of adjacent areas. The most important of these are: 1) North Park; 2) Middle Park and contiguous areas; 3) South Park; 4) Upper Arkansas Valley. North Park is nearly surrounded by the Park, Medicine Bow, and Rabbit Ears ranges. The rolling floor of the park supports an assemblage containing mammals characteristic of the Wyoming Basin and the Great Plains. Great Plains subspecies include *Spermophilus tridecemlineatus pallidus, Onychomys leucogaster arcticeps,* and perhaps *Vulpes velox velox.* Kinds typical of the Wyoming Basin include *Cynomys leucurus* and *Lagurus curtatus levidensis.* Communication of these local populations with conterminous ranges of the species is through a narrow corridor along the North Platte River in the vicinity of Northgate.

Middle Park, Egeria Park, the Elk River Valley and other such areas along the upper Yampa River and streams of the Upper Colorado drainage provide access to higher elevations for some mammals of the Wyoming Basin, notably *Cynomys leucurus, Lagurus curtatus levidensis,* and *Spermophilus tridecemlineatus parvus.* Some of these areas also provide corridors for saxicolous species of the Colorado Plateau, such as *Eutamias quadrivittatus, Peromyscus truei,* and *Bassariscus astutus.* Lanes of communication of these valleys and parks with areas of comparable landscape at lower elevations today are direct, but narrow in most instances.

South Park is a broad, high-elevation grassland. Of small mammals of the plains, only *Spermophilus tridecemlineatus pallidus* occurs there. Other grassland kinds are absent or are those more typical of highland herb communities—*Cynomys gunnisoni* and *Spermophilus richardsonii,* for example.

The most unique of the enclaves of nonmontane species within the Rocky Mountain Faunal Area is in the Upper Arkansas River Valley. The valley supports the largest assemblage of ectopic elements and is the only one in which endemism is seen. Endemic to the Upper Arkansas Valley is *Dipodomys ordii evexus.* The subspecies *Thomomys bottae internatus* is centered on the valley but extends onto the plains as well. A local race, *Thomomys bottae rubidus,* is known in the immediate vicinity of Cañon City. Grassland species of the Upper Arkansas Valley are *Spermophilus tridecemlineatus, Perognathus flavus, Dipodomys ordii,* and *Onychomys leucogaster.* Saxicolous kinds occupying the valley include *Spermophilus variegatus, Peromyscus boylii, Peromyscus truei, Peromyscus difficilis, Neotoma mexicana, Urocyon cinereoargenteus, Bassariscus astutus,* and *Spilogale putorius.* Suitable habitat for saxicolous kinds in the Upper Arkansas Valley is continuous with that to the south and east in the Raton Section, and mammals of such habitats frequently reach their altitudinal maxima in the valley. On the other hand, grassland kinds appear to be at least partially isolated from continuous populations on the plains.

Conspicuously absent from the foregoing discussion of faunal enclaves is the Upper Gunnison Valley. This large expanse of brushland supports a generalized fauna of eurychores enriched locally by montane kinds in suitable situations. Above the Black Canyon, the Gunnison Valley apparently is not suited to the rich xeric-adapted fauna of the Colorado Plateau Faunal Area. Furthermore, the valley is inaccessible to the fauna of the Wyoming Basin, an assemblage that seemingly would find conditions there wholly suitable.

Great Plains Faunal Area

Habitats of the plains of eastern Colorado include subhumid grassland, brushlands, sandhills, and riparian situations. Along the northern and southern boundaries of the state, broken country provides some habitats related to those of the foothills and mountains. Thus the distributional picture on the plains is not an altogether simple one. For purposes of the present discussion, the Great Plains Faunal Area is subdivided into four faunal districts. It will become obvious that these subdivisions are of unequal importance as natural areas.

The Northern High Plains Faunal District is related closely to other districts of the plains at both specific and subspecific levels. Kinds peculiar to the district in Colorado are *Thomomys talpoides attenuatus*, *Neotoma cinerea rupicola*, and *Erethizon dorsatum bruneri*. The most conspicuous feature of the fauna of the district is the absence of those mesic-adapted species of eastern affinity typical of the South Platte Valley.

The South Platte Valley Faunal District is closely related to districts to the north and south. However, the district differs from the Arkansas Valley and the Northern High Plains districts in the widespread occurrence of *Cryptotis parva*, *Sylvilagus floridanus*, and *Microtus ochrogaster*, and the presence of *Blarina brevicauda*. At the western margin of the district, *Zapus hudsonius* occurs.

The Arkansas Valley Faunal District is distinguished from the South Platte Valley by the presence of *Pappogeomys castanops*, *Peromyscus leucopus*, *Sigmodon hispidus*, and *Neotoma micropus*. *Sylvilagus floridanus* is present, but of limited occurrence. *Cryptotis parva* and *Microtus ochrogaster* probably occur in the lower part of the valley, but certainly they are not so prevalent along the Arkansas as in the South Platte Valley. In addition to differences in species composition, the faunas of the South Platte and Arkansas valleys differ at the subspecific level. The subspecific name in parentheses is the subspecies in the Arkansas Valley and follows the name of the subspecies in the South Platte Valley: *Scalopus aquaticus caryi* (*intermedius*), *Sylvilagus floridanus similis* (*llanensis*), *Spermophilus tridecemlineatus pallidus* (*arenicola*), *Spermophilus spilosoma obsoletus* (*marginatus*), *Geomys bursarius lutescens* (*jugossicularis*), *Dipodomys ordii luteolus* (*richardsoni*), *Odocoileus virginianus dacotensis* (*texanus*). Another possible pair of vicarious subspecies includes *Microtus ochrogaster haydenii* of the South Platte Valley and *M. o. taylori* in the Arkansas Valley.

All species in which the South Platte and Arkansas valleys differ at the subspecific level are inhabitants of mesic riparian communities or are taxa with a predilection for friable soils of floodplains or sandhills. None is characteristic of heavy residual soils of interfluves. Kinds of mammals that are typical of uplands (*Cynomys ludovicianus*, *Reithrodontomys montanus*, and *Onychomys leucogaster*, for example) exhibit no definable infraspecific variation in eastern Colorado.

Relationships between some of the subspecies listed (those of *Dipodomys ordii*, *Spermophilus tridecemlineatus*) apparently are clinal and perhaps ought not be recognized in formal nomenclature. Differences within other pairs (subspecies of *Scalopus aquaticus*, *Sylvilagus floridanus*) are marked and consistent, and contact and intergradation between them in Colorado is unknown.

In eastern Colorado, the most prominent barrier to reproductive continuity within species mentioned above is the Platte-Arkansas Divide. At its western end, the divide is wooded and forms an integral part of the Rocky Mountain Faunal Area. The divide continues eastward in a broad arc, with woodland becoming restricted to favored escarpments, and finally disappearing completely. A dry upland characterized by heavy soils extends eastward to the headwaters of the Smoky Hill River. The approximate extent of this area can be appreciated by referring to the distribution of *Thomomys talpoides retrorsus* (Fig. 55), a pocket gopher that is characteristic of the divide. However important the Platte-Arkansas Divide may be today as a barrier, probably it is less important now than in the past. The divide is being narrowed along its length by headward-cutting tributaries of master streams, particularly toward its eastern end.

The most distinctive subdivision of the Great Plains Faunal Area is the Raton Faunal District. Although showing certain affinities with the fauna elsewhere on the plains, strongest resemblances at the specific level are with districts of the Colorado Plateau Faunal Area. The following subspecies characterize the Raton Faunal District: *Pipistrellus hesperus maximus, Thomomys bottae cultellus, Neotoma albigula warreni,* and *Mustela frenata neomexicana.* The subspecies *Neotoma mexicana scopulorum* and *Mephitis mephitis varians* relate the fauna to that of the San Luis Valley.

A number of kinds of mammals occur in the Raton Faunal District and also extend northward in the broken sedimentary foothills and hogbacks that mark the interface between Rocky Mountain and Great Plains faunal areas. This assemblage includes: *Eutamias quadrivittatus quadrivittatus, Spermophilus variegatus grammurus, Peromyscus boylii rowleyi, Peromyscus truei truei, Peromyscus difficilis nasutus, Bassariscus astutus flavus,* and *Conepatus mesoleucus.* Northward along the mountain front, these taxa (and also *Neotoma mexicana fallax* and *Sciurus aberti ferreus*) constitute a gradually attenuating faunal unit narrowly restricted in vertical range and habitat preferences. Geographic relationships contraindicate recognition of this intrusive fauna as a major unit in the present ecogeographic analysis. Some ecological and historical implications of this fauna are discussed beyond.

The strong resemblance of the Raton Faunal District with the Dolores-San Juan and Grand Valley faunal districts at the specific level stems from the mutual occurrence of such characteristic mammals as: *Pipistrellus hesperus, Antrozous pallidus, Spermophilus variegatus, Peromyscus boylii, Peromyscus truei, Neotoma albigula, Neotoma mexicana,* and *Bassariscus astutus. Myotis thysanodes* also apparently unites the two areas although the species is too poorly known in Colorado to be useful in analysis.

Pairs of vicarious subspecies reduce coefficients of community between southeastern and southwestern parts of the state at the subspecific level. In the following list the southeastern subspecies is given first, followed by the southwestern subspecies in parentheses: *Pipistrellus hesperus maximus* (*hesperus*), *Sylvilagus audubonii baileyi* (*warreni*), *Lepus californicus melanotis* (*texanus*), *Eutamias quadrivittatus quadrivittatus* (*hopiensis*), *Spermophilus spilosoma marginatus* (*cryptospilotus*), *Thomomys bottae cultellus* (*aureus, howelli*), *Perognathus flavus bunkeri* (*hopiensis*), *Dipodomys ordii richardsoni* (*longipes, nexilis, sanrafaeli*), *Neotoma albigula warreni* (*laplataensis, brevicauda*), *Neotoma mexicana scopulorum* (*inopinata*), *Erethizon dorsatum epixanthum* (*couesi*), *Canis latrans latrans* (*mearnsi*), *Bassariscus astutus flavus* (*arizonensis*), *Mustela frenata neomexicana* (*nevadensis*), *Taxidea taxus taxus* (*berlandieri*), *Mephitis mephitis varians* (*estor*).

On the other hand, the subspecies *Reithrodontomys megalotis aztecus, Peromyscus boylii rowleyi,* and *Peromyscus truei truei,* among others, are common to the two areas.

Relationships between southeastern and southwestern parts of the state are those that would be expected. The areas are of comparable physiognomy and one would imagine that, given sufficient time, species composition of the faunal districts would become quite similar. On the other hand, the areas are separated in Colorado by extensive, absolute barriers to the passage of characteristic xeric-adapted species. Communication between the areas is necessarily by an erratic route south of the main ranges of the Rocky Mountains in New Mexico. That subspecific differentiation between the two areas is the rule, therefore, is hardly surprising.

Wyoming Basin Faunal Area

The Wyoming Basin Faunal Area shows less coincidence with physiographic units than do other faunal areas herein recognized. In general, the area embraces lower parts of the drainages of the Yampa and White rivers. Boundaries of the area are poorly delimited in the Yampa drainage above Craig. Complex interdigitation with the Rocky Mountain Faunal Area is apparent in the field but is obscured by the crude boundaries indicated in Fig. 125. Were knowledge of mammalian distribution in the extreme northwestern part of the state more detailed, recognition of faunal units coincident with the O-wi-yu-kuts Plateau and with the area west of the Green River might well be warranted. Data at hand, however, do not allow such resolution.

At the specific level, the Wyoming Basin Faunal Area most closely resembles other units at lower elevations on the Western Slope and the San Luis Valley Faunal District. At the subspecic level, alliance with the San Luis Valley is not pronounced.

Subspecies limited in Colorado to the Wyoming Basin Faunal Area or parts thereof are *Sylvilagus nuttallii grangeri, Eutamias dorsalis utahensis, Eutamias minimus minimus, Spermophilus tridecemlineatus parvus, Spermophilus lateralis wortmani, Thomomys talpoides ocius, Perognathus fasciatus callistus, Dipodomys ordii priscus,* and *Reithrodontomys megalotis megalotis.*

A relationship to North Park and to the upper Yampa and Colorado drainages is marked by the co-occurrence of *Cynomys leucurus* and *Lagurus curtatus.* Canyonlands of the Wyoming Basin Faunal Area relate to units of comparable physiography on the Colorado Plateau in the presence of *Myotis yumanensis, Antrozous pallidus, Peromyscus crinitus, Peromyscus truei, Neotoma cinerea arizonae,* and *Bassariscus astutus arizonensis.*

Colorado Plateau Faunal Area

The Colorado Plateau Faunal Area as a whole is related closely to the San Luis Valley and to the Wyoming Basin at the specific level. At the subspecific level, the same relationships are apparent, but are less pronounced.

The Colorado Plateau Faunal Area is bisected by the highland corridor of the Uncompahgre Plateau. A northern segment, the Grand Valley Faunal District, is a coherent faunal unit characterized by xeric-adapted species occupying the Grand Valley of the Colorado and the valleys of the Gunnison River and its tributaries. The fauna undergoes gradual attrition with increasing elevation in the valleys, and general limits are reached at Glenwood Canyon on the Colorado and at the Black Canyon of the Gunnison. Along the Uncompahgre River, the limit is between Colona and Ridgway.

The Dolores-San Juan Faunal District comprises valleys of those streams and their tributaries. Complex interdigitation with the Rocky Mountain Faunal Area is abundantly apparent in the field. Insular extensions of the montane fauna on Ute Peak and Mesa Verde are included within the faunal district as delineated in figure 125.

The two subdivisions of the Colorado Plateau Faunal Area show closer alliance than any other pair of units in the present analysis, at both specific and subspecific levels. The Grand Valley Faunal District includes ranges of two species not found to the south, *Cynomys leucurus* and *Neotoma lepida.* Contrariwise, *Notiosorex crawfordi, Spermophilus spilosoma, Cynomys gunnisoni, Perognathus flavus* and *Neotoma albigula* occur in the Dolores-San Juan district, but not in the Grand Valley. *Myotis thysanodes* is a possible sixth species distinguishing the Dolores-San Juan district. *Microtus mexicanus* occurs on Mesa Verde as an apparent relict. Pairs of vicarious subspecies in the Grand Valley and in the Dolores-San Juan district (in parentheses) are: *Ammospermophilus leucurus pennipes* (*cinnamomeus*), *Thomomys bottae howelli* (*aureus*), *Perognathus apache caryi* (*apache*), *Dipodomys ordii sanrafaeli* (*nexilis, longipes*), *Vulpes macrotis arsipus* (*neomexicana*).

Other subspecific differences between the two areas are found in *Erethizon dorsatum, Canis latrans, Taxidea taxus,* and *Lynx rufus.* In each of these cases, the fanual area as a whole is a zone of intergradation, but the Grand Valley district supports subspecies characteristic of the mountains, whereas the

Dolores-San Juan Faunal District is occupied by a kind autochthonous in the desert Southwest.

The Dolores-San Juan Faunal District is an area of extreme ecological complexity. Perhaps the unit could be logically subdivided. The subspecies *Dipodomys ordii longipes* and *Neotoma albigula laplataensis* characterize the San Juan drainage, and some open-country species (*Spermophilus spilosoma, Perognathus flavus*) are restricted in southwestern Colorado to the southern part of the faunal district. On the other hand, *Dipodomys ordii nexilis* and *Neotoma albigula brevicauda* occur only in the Dolores-San Miguel watershed. The divide trending northwesterly from Lone Cone and the Dolores Canyon together constitute a "filter barrier" subdividing the faunal district as defined here.

Discussion

The near coincidence of mammalian distributional areas of the present study with other such ecogeographic units is to be expected and is, in fact, the case. Differences among ecogeographic systems generally reflect variations in levels of resolution of the methods employed and in the precision of the basic distributional data at hand.

J. A. Allen (1892) suggested an hierarchical system of units that were essentially ecogeographic, consisting of realms, regions, provinces, subprovinces or districts, and faunae or florae. Temperate North America constituted a region within the North Temperate Realm. The North American Region was subdivided into Cold Temperate and Warm Temperate subregions, and the latter area was partitioned into an eastern Humid Province and a western Arid Province.

The mountains of Colorado lay within the Cold Temperate Subregion, and areas at lower elevations on either side were part of the Arid Province of the Warm Temperate Subregion. Coloradan portions of the Arid Province all were within the Campestrian (as opposed to Sonoran) Subprovince. The ultimate ecogeographic units within Colorado were four: Great Plains District, Hudsonian Fauna, Canadian Fauna, Great Basin District.

The Great Plains District agrees closely with the Great Plains Faunal Area of the present study. The Great Basin District corresponds in a general way with the Wyoming Basin and Colorado Plateau faunal areas, although extension of the district much farther eastward was suggested by Allen than is admitted on the basis of present evidence. Mountainous parts of the state were subdivided into faunae that essentially represent life-zones or life-belts. As has been pointed out, differences between mammals of Hudsonian and Canadian life-zones in Colorado are not marked.

Dice (1943) mapped the occurrence of three biotic provinces in Colorado. The Kansan Biotic Province within the state encompassed the eastern plains and the northern part of the Raton Section, and corresponds closely with the Great Plains Faunal Area of the present study. The southern part of the Raton Section was included by Dice in the Navahonian Biotic Province, a relationship clearly indicated by mammalian faunal resemblances at the specific level (Table 29) but not formalized in the present ecogeographic scheme, inasmuch as faunas of southeastern and southwestern parts of the state are discontinuous in Colorado.

The Navahonian Biotic Province of Dice coincides with the Colorado Plateau and parts of adjacent physiographic provinces in New Mexico and southern Colorado. The biotic province corresponds in Colorado to the Colorado Plateau Faunal Area of the present study, plus a part of the Raton Faunal District. It is to the credit of Dice to have united the piñon-juniper communities of southwestern and southeastern Colorado in a single unit broadly continuous through central New Mexico, although probably the extent of the Navahonian Biotic Province in southeastern Colorado is unduly conservative as mapped by him.

Dice's Coloradan Biotic Province is the least homogeneous of biotic provinces in Colorado from the standpoint of mammalian distribution. Corresponding mammalian distributional areas are the Rocky Mountain and Wyoming Basin faunal areas and the San Luis Valley Faunal District. Reference to Fig. 126 suggests that these units are not closely related by their mammalian faunas.

The Coloradan Biotic Province includes mountains and basins of the North Platte and Green drainages of Wyoming, the Uinta and Wasatch mountains in Utah, and related ranges in southeastern Idaho. Relationships between mammalian faunas of the Middle and Southern Rocky Mountains are discussed as an aspect of historical distribution beyond.

Hagmeier and Stults (1964) and Hagmeier (1966) delineated mammalian provinces in North America, explicitly utilizing biotic provinces of Dice (1943), as refined by Kendeigh (1961:273). An hierarchic arrangement of distributional units was erected, based on statistical analysis of faunal relationships. Parts of Colorado were included in three subregions as follows (Hagmeier, 1966:288-293):

- Coniferan Subregion
    - Mountain Superprovince
        - Coloradan Province
- Sonoran Subregion
    - Navaho Superprovince
        - Uintian Province
        - Navahonian Province
- Deciduan Subregion
    - Kansas Superprovince
        - Kansas Province
    - Texas Superprovince
        - Balconian Province

The Coloradan Mammal Province of Hagmeier (1966:290) corresponds in the south with the Coloradan Biotic Province of Dice, but is more inclusive than the latter unit, extending northward into Montana. Within Colorado, the mammal province and the biotic province are coincident. The San Luis Valley was not distinguished as a faunal unit by Hagmeier.

West-central and southwestern Colorado generally coincide with the Uintian province of Hagmeier (*loc. cit.*). The Navahonian province barely appears in the state in the extreme southwest. Subdivision of the fauna of the Colorado Plateau by Hagmeier is thus in partial disagreement with the units outlined by me, in which Colorado and Dolores-San Juan drainages are seen as distinctive faunal districts within a single faunal area.

As was mentioned previously, Dice (1943) mapped a part of the Raton Section as lying within the Navahonian Biotic Province, but Hagmeier departed from that usage. The faunal distinctiveness of southeastern Colorado was suggested by the fact that the Balconian Mammal Province (Hagmeier, *loc. cit.*) was mapped as barely extending into the state. However, the relationship thereby implied is with the Llano Estacado and the Edwards Plateau, and not with the broken piñon-juniper country of central New Mexico.

The Kansas Mammal Province of Hagmeier coincided closely with the biotic province of that name. Subdivisions of the Great Plains Faunal Area recognized herein were not apparent at the level of analysis used by him.

The mathematical methodology of Hagmeier and Stults (1964) and Hagmeier (1966) resulted in a statistically defined hierarchy of ecogeographic units. The lack of complete concordance between units derived by them and those of the present analysis stems in part from differences in scale of range maps available to them and those used by me. Coefficients of community differ widely between the present and previous studies because I have used only differential taxa in my tabulations and have omitted poorly known mammals. Earlier studies have used virtually all kinds, for over a continental area few species are ubiquitous, and local imprecision of range maps may be justifiably ignored.

Of particular interest in Hagmeier's (1966) study is the occurrence of subregional and superprovincial boundaries in Colorado. The state contains parts of three subregions and four superprovinces (Hagmeier, *op. cit.*:293). This is as many supraprovincial limits as occur in any other state. That fact emphasizes the faunal heterogeneity over the state of Colorado, and corroborates previous statements concerning the marked distinctiveness of mammalian distributional units, particularly the faunal areas herein utilized. The occurrence of such limits suggests further that an historic appraisal of the fauna would be of some interest.

AREAL DISTRIBUTION

Udvardy (1969:282) observed that "analysis of a local . . . fauna list will show that

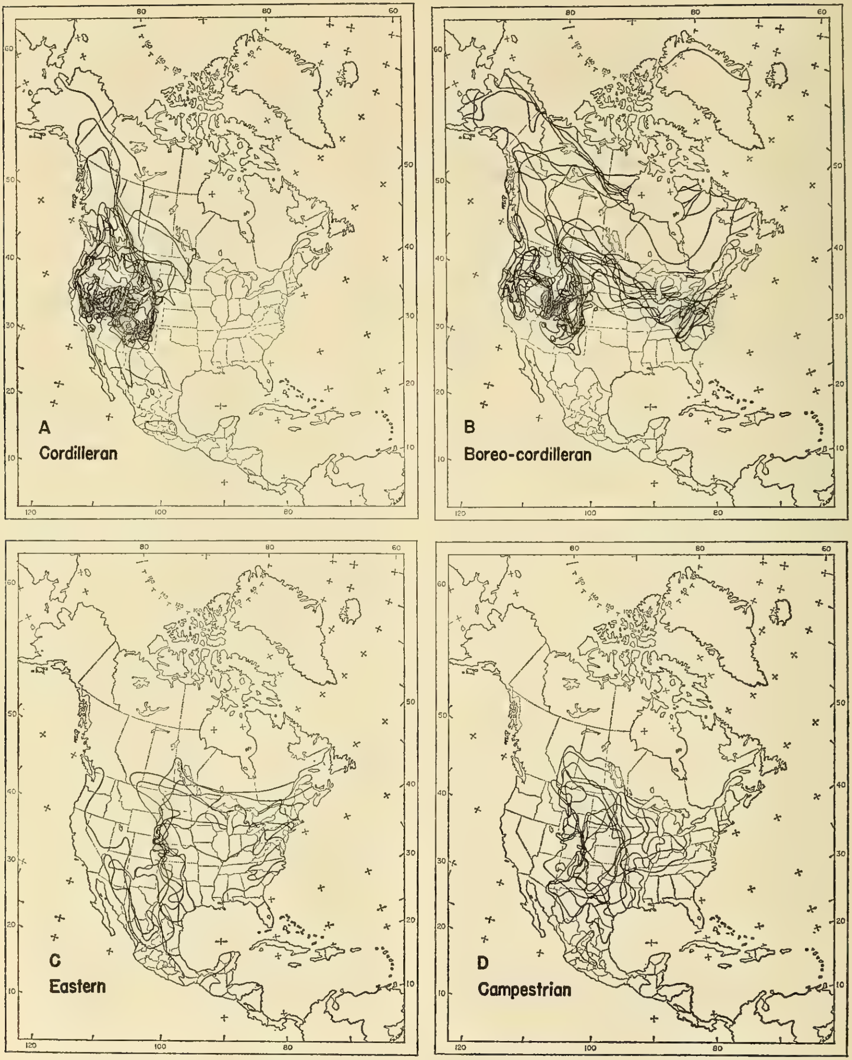
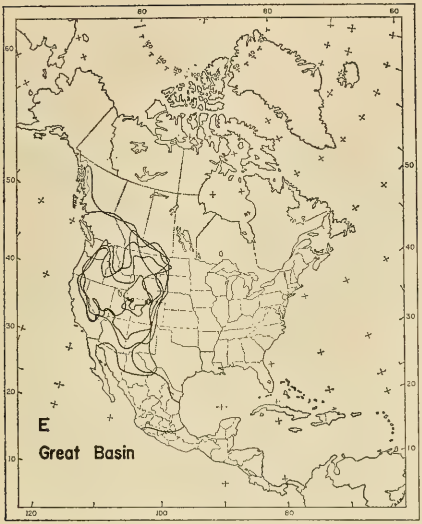


Fig. 127. Superimposed continental ranges of: A, 13 Cordilleran species; B, 13 Boreo-cordilleran species; C, eight Eastern species; D, nine Campestrian species; E, six Great Basin species; F, five Yuman species; G, 28 Chihuahuan species; H, 26 Widespread species.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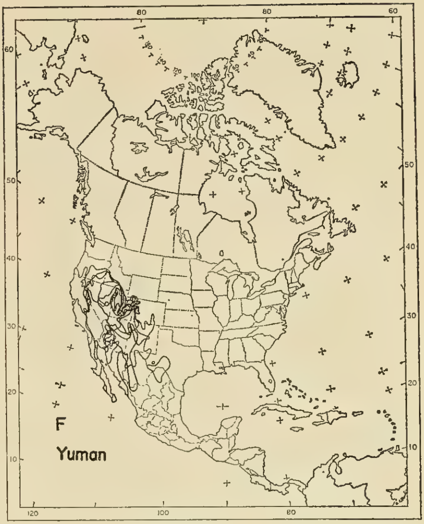
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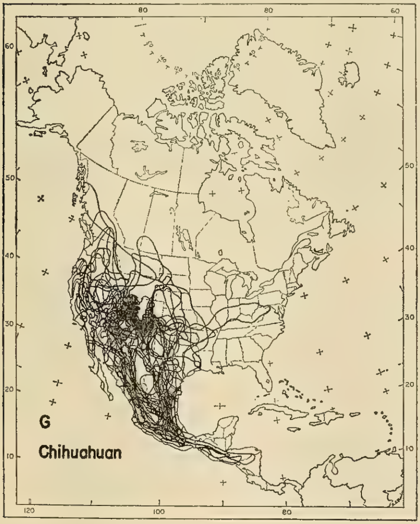
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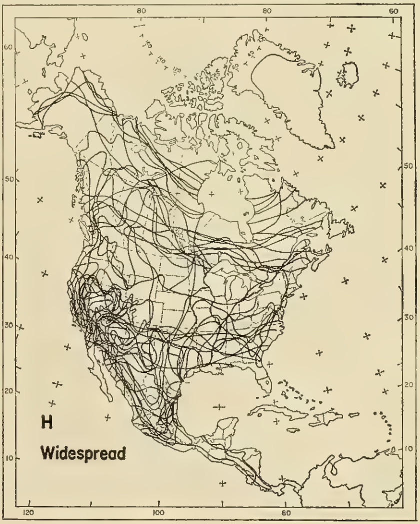
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the constituent species fall into groups with respect to the shape of their geographic areas." The cohesiveness of such groups may relate to common geographic origin or to common routes of movement (*op. cit.*:281). A. H. Miller (1951:582) delineated avifaunas ". . . on the basis of strong or repeated association of species which have similar centers of distribution and probably also similar areas of origin." The term "faunal element" is applicable to such groups of species.

Areographic analysis is of interest because it enables the provisional segregation of faunal elements of possible historical integrity from assemblages with compatible and complementary, yet coincidental ecology. A given local fauna, or the fauna of an ecogeographic unit, may consist of species representing a number of semi-independent faunal elements. To distinguish faunal elements—and to maintain their distinction from ecofaunal units—is important but difficult. Not infrequently, faunal elements agree in large part with ecological entities (Udvardy, 1963:1165), but the two constructs represent different notions involving disparate rationales and applications.

Whereas ecogeographic units may include species with widely different historical relationships, faunal elements, recognized by the coincidence of specific ranges, may encompass a spectrum of ecological potential. Examples are apparent among Coloradan mammals. *Sciurus aberti, Reithrodontomys megalotis,* and *Neotoma mexicana* are considered to represent a single faunal element, but evince diverse ecological relationships, owing perhaps to diversity within the hypothetical common area of dispersal as well as to differential adaptive response to areas now occupied. On the other hand, the Wyoming Basin Faunal Area, an ecogeographic unit, includes species of a number of faunal elements (as is indicated in Fig. 133 and discussed beyond).

Faunal elements were recognized solely by the character of the ranges of constituent species, both the overall range and the range in and near Colorado. A conscious effort was made to disregard ecological considerations in the definition of faunal elements. Outline maps of ranges of species were redrawn after Hall and Kelson (1959). Boundaries of ranges follow that work except that some peripheral isolates were merged with conterminous ranges to simplify maps of compiled ranges. Limits within Colorado were refined wherever possible on the basis of distributional data provided in accounts of species herein.

Faunal elements were sorted by a procedure suggested by Polunin (1960:212) for identifying elements of a local flora: 1) remove exotic and occasional species; 2) remove eurychores; 3) remove endemic and autochthonous kinds; 4) divide the remainder according to the character of their ranges. A comparable protocol was outlined by Udvardy (1969:283).

After members of faunal elements had been identified, composite maps of North American limits of species in each element were prepared (Fig. 127). Species listed as members of more than one faunal element are designated by an asterisk in lists of constituent species beyond. The ranges of those species were not included on composite maps.

Nine faunal elements are recognized in Colorado as follows: Cordilleran, Boreocordilleran, Eastern, Neotropical, Campestrian, Great Basin, Yuman, Chihuahuan, Autochthonous Coloradan. A tenth category includes species too widespread to identify with one or another faunal element. A faunal element is defined by the ranges of its included species. Descriptions of mammalian faunal elements recognized in Colorado follow.

Cordilleran Faunal Element

No single center of distribution is obvious for the species of this element. Areas of general coincidence (Fig. 127A) broadly overlie the Middle and Southern Rocky Mountains and also the Sierra Nevada. Fourteen species, as follows, comprise the Cordilleran Faunal Element:

Sorex vagrans
Sorex nanus
Ochotona princeps
Eutamias umbrinus
Marmota flaviventris
Spermophilus richardsonii
Spermophilus lateralis
*Thomomys talpoides**

Neotoma cinerea
Microtus montanus
Microtus longicaudus
Zapus princeps
*Bison bison**
Ovis canadensis

In Colorado, nearly all members of the Cordilleran Faunal Element are restricted to areas of higher elevation. Only *Thomomys talpoides* and *Neotoma cinerea* have extended eastward to any extent from the mountainous core of the state.

Only *Spermophilus richardsonii* among Cordilleran species reaches its southern limit in Colorado, and, as was indicated in the account of that species, the limit is an obviously dynamic one. Most Cordilleran species occur southward into New Mexico and Arizona, frequently as peripheral relicts, and some occur also in Mexico.

Of 14 Cordilleran species, two kinds (*Sorex vagrans, Microtus longicaudus*) occur north to Alaska, and two (*Neotoma cinerea, Zapus princeps*) reach limits in Yukon Territory. No other species occurs north of the Cariboo and Columbia ranges of southern British Columbia.

Boreo-cordilleran Faunal Element

This element consists of 13 species in Colorado. Ranges of included kinds (Fig. 127B) encompass the mountains of western North America, the continental interior at middle or high latitudes, and frequently the highlands of eastern United States as well. Boreo-cordilleran species are:

Sorex cinereus
Sorex palustris
Microsorex hoyi
Lepus americanus
Eutamias minimus
Tamiasciurus hudsonicus
Clethrionomys gapperi
Phenacomys intermedius
Microtus pennsylvanicus
Martes americana
Mustela erminea
Gulo gulo
Lynx canadensis

In Colorado, all members of this element save *Microtus pennsylvanicus* are restricted to the mountains. That species is included with the Boreo-cordilleran element with reservation. Although resembling in outline other members of the element, the range of the meadow vole is more extensive to the southeast than those of other Boreo-cordilleran kinds.

The present distribution of this faunal element is in central Canada, in a broad zone from about Great Slave Lake and the Peace River southeasterly to southern Ontario. Extensions southward from this center are along corridors of high elevation. The Southern Rocky Mountains and the Appalachian Highland have the following seven boreal species in common: *Sorex cinereus, Sorex palustris, Microsorex hoyi, Lepus americanus, Tamiasciurus hudsonicus, Clethrionomys gapperi,* and *Microtus pennsylvanicus.* Six species occur both in the southern Rockies and the Sierra Nevada: *Sorex palustris, Lepus americanus, Eutamias minimus, Martes americana, Mustela erminea,* and *Gulo gulo.*

Internal relationships within Boreo-cordilleran and Cordilleran faunal elements show marked contrasts. As a rule, the Boreo-cordilleran fauna extends much farther north than does the Cordilleran fauna. At least two species (*Mustela erminea* and *Gulo gulo*) are of Holarctic distribution, and those with strict North American limits find them in Alaska or the Yukon; the pattern of truncation of ranges in central British Columbia is not seen. On the other hand, the southern limits of the Boreo-cordilleran fauna are farther north than are those of the Cordilleran fauna. Only *Eutamias minimus, Tamiasciurus hudsonicus,* and *Clethrionomys gapperi* occur at all south of central New Mexico, and the occurrence of those species is pronouncedly insular. The southern limits of most Boreo-cordilleran kinds are in northern New Mexico and southern Utah. One species, *Microsorex hoyi,* is present in north-central Colorado as a relict population.

Another distinction between Boreo-cordilleran and Cordilleran species in Colorado is in altitudinal distribution. As a general rule, Boreo-cordilleran kinds are more narrowly restricted to dense forests of relatively high elevations than are members of the Cordilleran element. *Eutamias minimus* is an obvious exception to this generalization as well as to the preceding one. Also, its northern limits are farther south than is modal for members of the faunal element. In fact, its inclusion with the Boreo-cordilleran element on strictly geographic grounds probably is misleading and a distortion of historic relationships. However, such distortion is perhaps inevitable when solely areal definition of elements is utilized.

Eastern Faunal Element

This element (Fig. 127C) includes eight species entering Colorado from the east or southeast, as follows:

Cryptotis parva
Blarina brevicauda
Scalopus aquaticus
Lasiurus borealis
Sylvilagus floridanus
Sciurus niger
Peromyscus leucopus
Neotoma floridana

The center of distribution of the Eastern Faunal Element is the Lower Mississippi Valley and the Central Lowlands of North America. Although widespread in North America, *Lasiurus borealis* enters Colorado in the pattern characteristic of members of the Eastern element. Coloradan limits of all members of this faunal element are east of the mountain front.

Neotropical Faunal Element

Two species of obvious tropical affinities (not mapped) occur in eastern Colorado, *Didelphis marsupialis* and *Sigmodon hispidus*. In Colorado, distributional patterns of these species are analogous to those of members of the Eastern Faunal Element. However, their continental distributions are distinctive; both kinds occur southward into South America. These Neotropical mammals are invasive species, and either or both may have become established in Colorado within historic times.

Campestrian Faunal Element

Fourteen Coloradan mammals have ranges generally coincident with part or all of the Great Plains (Fig. 127D) and are herein designated the Campestrian Faunal Element:

*Lepus townsendii**
Spermophilus tridecemlineatus
Cynomys ludovicianus
Geomys bursarius
Perognathus fasciatus
Perognathus flavescens
Perognathus hispidus
Reithrodontomys montanus
*Onychomys leucogaster**
Microtus ochrogaster
Vulpes velox
Mustela nigripes
*Antilocapra americana**
*Bison bison**

The present center of distribution of this element is in central Nebraska, central and western Kansas, and eastern Colorado. Northern and southern limits coincide broadly with the grassland of central North America. Most species occur only west of the Mississippi River, but *Spermophilus tridecemlineatus*, *Geomys bursarius*, and *Microtus ochrogaster* occur east of the river along a "Prairie Peninsula." *Bison bison* formerly enjoyed an eastern range more extensive than any of these other kinds.

In Colorado all members of this faunal element occur on the eastern plains, and some also occur in the Wyoming Basin or the San Luis Valley. *Mustela nigripes*, *Antilocapra americana*, and *Bison bison* once were nearly statewide in suitable habitats.

Great Basin Faunal Element

This faunal unit consists of 10 Coloradan species, as follows:

Sorex merriami
Myotis volans
Myotis evotis
Sylvilagus nuttallii
*Lepus townsendii**
Cynomys leucurus
*Thomomys talpoides**
*Onychomys leucogaster**
Lagurus curtatus
*Antilocapra americana**

The center of distribution of these species is coincident with the northern Great Basin and the Wyoming Basin (Fig. 127E). The pattern of occupation in Colorado is complex, with some species mostly restricted to the Wyoming Basin Faunal Area, whereas others occur through the mountains, or even eastward on the plains.

Yuman Faunal Element

The five Coloradan members of this element are: *Eutamias dorsalis, Ammospermophilus leucurus, Thomomys bottae, Neotoma lepida,* and *Peromyscus crinitus.* The center of distribution of the element is the lower Colorado drainage (Fig. 127F). The distributional pattern of these species is not greatly distinct from that of some members of the Great Basin or Chihuahuan (see beyond) faunal elements, and the five species might be included with either of those units. However, members of the Yuman Faunal Element have less extensive ranges than are typical of members of the above-mentioned units, and the occurrence of Yuman kinds in Colorado generally is more restricted. Only *Thomomys bottae* is established east of the Continental Divide.

Chihuahuan Faunal Element

Some 28 species of Coloradan mammals are identified with this faunal element:

Notiosorex crawfordi
Myotis californicus
Myotis yumanensis
Myotis thysanodes
Pipistrellus hesperus
Plecotus townsendii
Antrozous pallidus
Sylvilagus audubonii
Lepus californicus
Spermophilus spilosoma
Spermophilus variegatus
Sciurus aberti
Pappogeomys castanops
Perognathus flavus
Perognathus apache
Dipodomys ordii
Reithrodontomys megalotis
Peromyscus boylii
Peromyscus truei
Peromyscus difficilus
Neotoma micropus
Neotoma albigula
Neotoma mexicana
Microtus mexicanus
Vulpes macrotis
Urocyon cinereoargenteus
Bassariscus astutus
Conepatus mesoleucus

The Chihuahuan Faunal Element is the largest such areographic component of the Coloradan mammalian fauna. Reference to Fig. 127G suggests the distributional complexity of the element. Initially, it was suspected that the unit would be subdivisible into at least two elements of comparable importance. However, superimposition of all ranges indicates a single predominant center of distribution generally concordant with the basin and range region of Chihuahua, western Coahuila, and northern Durango. Nor is subdivision indicated (at the specific level) by the relationships of these kinds in Colorado. Coloradan distributions of most of the species are closely comparable.

Findley (1969) discussed faunal differences between the Sonoran and Chihuahuan deserts. Communication between populations across the Continental Divide, when it occurs at all, typically is over the Deming Plain in New Mexico, near the Chihuahuan boundary. Species of the Chihuahuan Faunal Element in Colorado generally are not mammals of desert basins, however, but are saxicolous kinds of semiarid highlands or relatively euryecious species of grasslands. Such species generally find intermittant corridors for dispersal across the Continental Divide in central or even northern New Mexico. As a rule, truly desert-adapted mammals do not reach Colorado. Gennaro (1968) discussed northern limits of four desert rodents (*Perognathus intermedius, Dipodomys merriami, Peromyscus eremicus, Onychomys torridus*) in the Rio Grande Valley. Limits were found to lie between Albuquerque and Penablanca, New Mexico, some 100 miles to the south of Colorado.

Southern limits of members of the Chihuahuan Faunal Element are mostly north of the Isthmus of Tehuantepec. A few species extend southeastward to Guatemala, Honduras, or Nicaragua. In the north, a few kinds occupy the Columbia Plateau or even range northward into British Columbia. One spe-

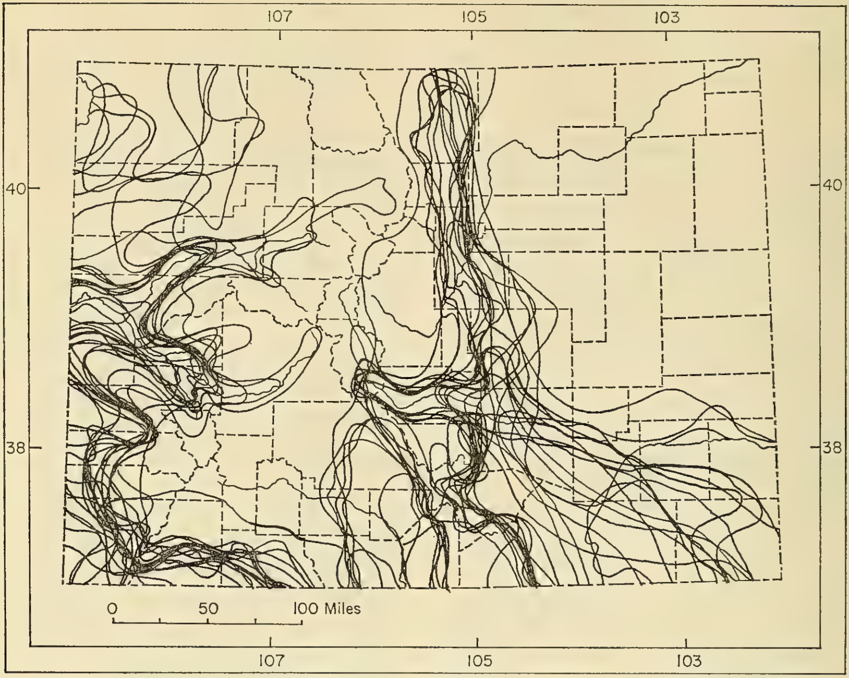

FIG. 128. Superimposition of Coloradan limits of 28 species of Chihuahuan Faunal Element.

cies, *Plecotus townsendii*, occurs well eastward into the Ohio Valley. Three species (*Sylvilagus audubonii*, *Dipodomys ordii*, *Reithrodontomys megalotis*) have established contact between Great Plains and Great Basin segments through the Wyoming Basin and thus surround the Southern Rocky Mountains. *Onychomys leucogaster* is a possible fourth such species. However, the northern grasshopper mouse is herein considered to represent Great Basin and Campestrian faunal elements, inasmuch as the species ranges little south of the Mexican boundary.

Urocyon cinereoargenteus (not mapped) is included with the Chihuahuan element on the basis of its range in and near Colorado. Based on its continental distribution, the species probably would be considered a eurychore.

Although limits of Chihuahuan species occur generally over western United States, the area of greatest coincidence of limits obviously is in Colorado and immediately adjacent areas (Fig. 127G). It is of some interest to examine those Coloradan limits in more detail. A superimposition of Coloradan limits of the 28 species of the Chihuahuan Faunal Element is shown in figure 128; the pattern is like that shown in figure 127G, but resolution is substantially greater.

At most, a single member of the Chihuahuan element (*Plecotus townsendii*) crosses the Continental Divide in Colorado. A preponderance of limits occurs in major valleys of the Western Slope. Some kinds range into the San Luis Valley.

On the Eastern Slope, four recurrent patterns are indicated. Some species (*Sylvilagus* *audubonii, Spermophilus spilosoma, Perognathus flavus, Dipodomys ordii, Reithrodontomys megalotis*) occur widely on the plains and are limited abruptly at the mountain front. A number of species (*Myotis yumanensis, Antrozous pallidus, Pappogeomys castanops, Neotoma albigula, Neotoma micropus*) are limited mostly to the Raton Section. A third group of species ranges northward along the mountain front and thence up the Arkansas Valley, some occurring as high as Salida. *Notiosorex crawfordi, Peromyscus truei,* and *Peromyscus boylii* are among these species, as are several grassland kinds of Chihuahuan affinities.

Northward from the Arkansas River, Chihuahuan species occur in a gradually attenuating intrusive fauna. *Peromyscus truei* drops out in the Fountain Creek drainage near Colorado Springs, as does *Thomomys bottae* (considered with the Yuman Faunal Element, but comparable to Chihuahuan species in its distribution on the Eastern Slope). *Bassariscus astutus* apparently occurs somewhat farther north. The Chihuahuan species *Spermophilus variegatus, Sciurus aberti, Peromyscus difficilis,* and *Neotoma mexicana,* along with *Eutamias quadrivittatus* (a possible Coloradan autochthon) occur in a narrow band of suitable habitat northward nearly to the Wyoming boundary. All are present in the foothills west of Livermore, yet only one, *Sciurus aberti,* is known to occur in Wyoming (and that species is known in Wyoming only by specimens from within a mile north of the Coloradan boundary). The abrupt truncation of this "Chihuahuan Intrusive" in the vicinity of the North Fork of the Cache la Poudre River is a matter of some interest. The limit of *Sciurus aberti* doubtless is linked with the disruption of suitable habitat of ponderosa pine woodland. The other species involved in this peculiar pattern are saxicolous mammals typical of rocky canyonlands. Broken terrain continues intermittently northward into Wyoming, but the North Fork of the Poudre is the northernmost stream in the South Platte drainage that flows in a major canyon. My present hypothesis is that the abrupt northern limit of the Chihuahuan Intrusive is a consequence of the unique microclimatic regime of the thermal zone of canyon walls. So obvious a case of coincidence of limits certainly deserves further study.

Autochthonous Coloradan Faunal Element

At least two species (not mapped) are of sufficiently limited distribution outside of Colorado to suggest their possible origin in or near the state. The two species are *Eutamias quadrivittatus* and *Cynomys gunnisoni.* Of interest is the fact that each of these species is divisible into two quite distinctive subspecies, a western race that occurs at lower elevations and an eastern montane race. Ranges of both species resemble those of members of the Chihuahuan element to some extent, although their montane subspecies range to higher elevations in Colorado than does any Chihuahuan species.

Other possible Coloradan autochthons are *Sorex nanus* and *Sciurus aberti.* The first of these is herein considered a Cordilleran species, the latter among the Chihuahuan Element.

Eurychores

Twenty-six species of Coloradan mammals (Fig. 127H) are sufficiently widespread over North America to preclude their identification with one or another faunal element on the basis of the character of the range. These kinds are:

Myotis lucifugus
Myotis leibii
Lasionycteris noctivagans
Eptesicus fuscus
Lasiurus cinereus
Castor canadensis
Peromyscus maniculatus
Ondatra zibethicus
Erethizon dorsatum
Canis latrans
Canis lupus
Vulpes vulpes
Ursus arctos
Ursus americanus
Procyon lotor
Mustela frenata
Mustela vison
Spilogale putorius
Mephitis mephitis
Taxidea taxus
Lutra canadensis

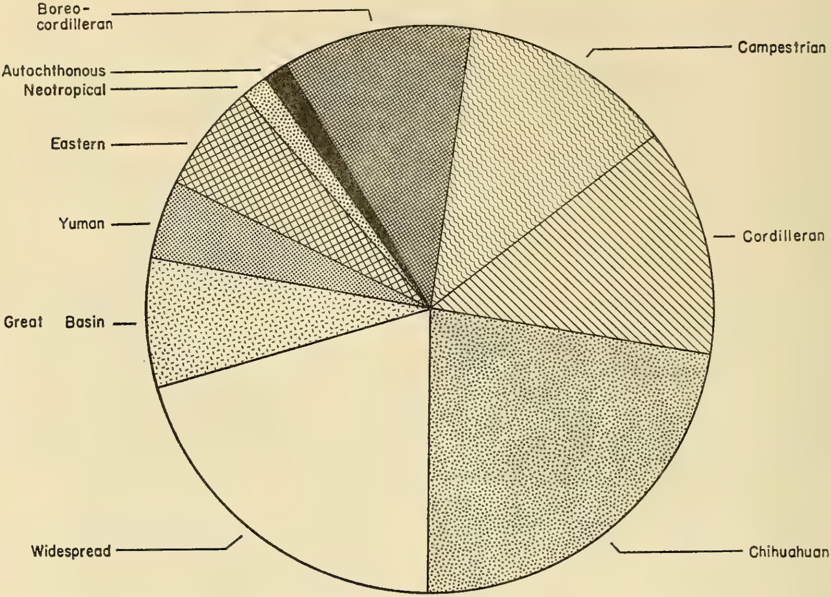

FIG. 129. Proportional contribution to Coloradan fauna of each of nine areographic theriofaunal elements and of widespread species.

Felis concolor
Lynx rufus
Cervus canadensis
Odocoileus hemionus
Odocoileus virginianus

An additional species, *Zapus hudsonius* (not mapped), has a continental distribution unlike that of any other Coloradan mammal and is included in this discussion of widespread species for want of any more meaningful association. The meadow jumping mouse ranges across boreal North America and occurs southward in the eastern and central United States. The species is present as an apparent relict in Colorado, restricted to the South Platte drainage immediately adjacent to the mountain front. In many respects, the range of *Zapus hudsonius* resembles those of species herein termed the Boreo-cordilleran Faunal Element, but in Colorado the species does not occur in the mountains. Rather, a closely related Cordilleran species, *Zapus princeps*, occupies the highlands of Colorado.

The proportional contribution to the mammalian fauna of Colorado by each of nine distinctive theriofaunal elements and of widespread species is shown in figure 129. Obviously, the most important contributions are on the part of eurychores and Chihuahuan species, with prominent proportions due to a number of other elements.

The geographic centers of co-occurrence of members of eight faunal elements (Neotropical not indicated) is shown in figure 130. The meaning of such centers is a moot question. At the least they are centers of maximal coincidence of ranges, that area occupied in common by all members of the faunal element. In the most sanguine view, such areas are centers of origin. In fact, probably each such center has a distinctive eco-historical

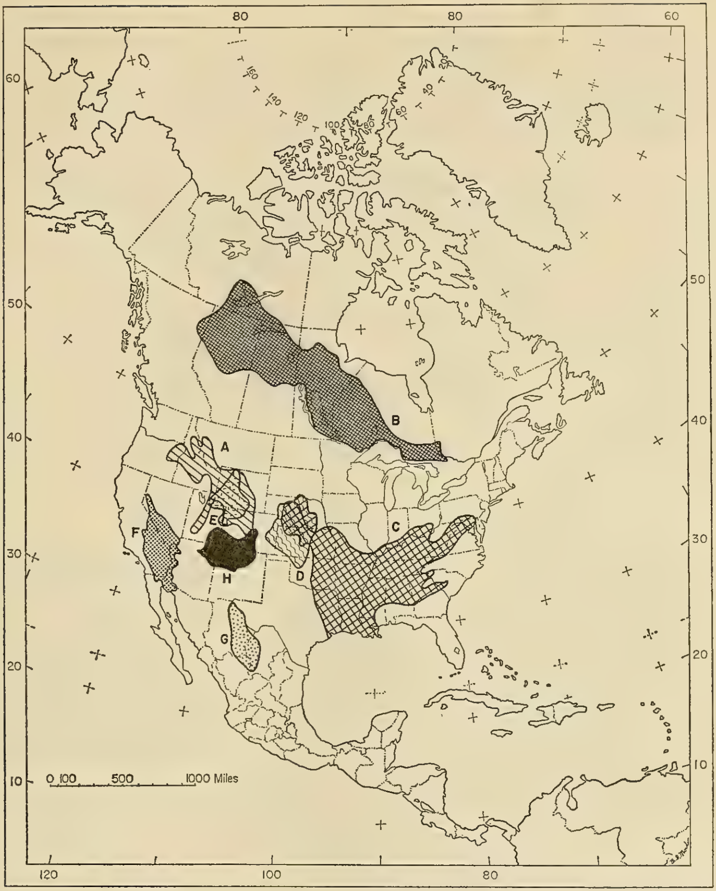

FIG. 130. Centers of co-occurrence of members of eight areographic theriofaunal elements: A, Cordilleran; B, Boreo-cordilleran; C, Eastern; D, Campestrian; E, Great Basin; F, Yuman; G, Chihuahuan; H, Autochthonous Coloradan.

meaning, its evolutionary significance lying somewhere between the above extremes. For a review of theories concerning centers of distribution, see Udvardy (1969:283). In a local faunal study such as the present one, we are actually concerned with only parts of faunal elements, and with those parts only as they occur in Colorado. Hence, further discussion of centers of occurrence seems unwarranted at this point.

Inasmuch as faunal elements were defined wholly by geographic criteria, it is of some interest to compare these units with natural areas based to some degree on ecological con-

TABLE 31

Approximate concordance of major Coloradan community-types and ecogeographic distributional areas.

Mammalian Distributional Area	Subhumid grassland	Plains wetlands	Plains deciduous woodland	Saxicoline brush	Sagebrush	Semidesert scrub	Pygmy conifer woodland	Ponderosa pine woodland	Montane forest	Montane and subalpine meadow	Subalpine forest	Highland streambank, shoreline	Aspen woodland	Alpine meadow, fellfield
Wyoming Basin	—	—	—	X	X	X	X	—	—	—	—	—	—	—
Northern High Plains	X	—	—	X	—	—	—	—	—	—	—	—	—	—
South Platte Valley	X	X	X	—	X	—	—	—	—	—	—	—	—	—
Arkansas Valley	X	X	X	—	X	—	—	—	—	—	—	—	—	—
Rocky Mountain	—	—	—	X	X	—	X	X	X	X	X	X	X	X
Grand Valley	—	—	—	X	—	X	X	—	—	—	—	—	—	—
Dolores-San Juan	X	—	—	X	X	X	X	X	—	—	—	—	—	—
San Luis Valley	X	—	—	—	—	X	X	—	—	—	—	—	—	—
Raton	X	—	—	X	—	—	X	X	—	—	—	—	—	—

siderations. As a preliminary, the relationships of ecological and ecogeographic units *inter se* should be re-emphasized. The approximate concordance of major Coloradan community-types and ecogeographic mammalian distributional areas is given in table 31. A graphic approximation of the table can be had by comparing a vegetation map (such as figure 5) with the outline map of distributional areas (Fig. 125). The correspondence between life-zones and mammalian distributional areas is so close that adequate comparison of figures 118 and 125 can be made by eye. Broadly speaking, the Upper Sonoran Life Zone embraces all mammalian distributional areas save the Rocky Mountain Faunal Area. The latter ecogeographic unit subsumes the other four Coloradan life-zones.

Cumulative percentage composition of the mammalian component of Coloradan life-zones attributable to each of the several areographic faunal elements is represented by bar diagrams in figure 131.

The percentage of each theriofaunal element characteristically occurring in each life-zone is shown in table 32. It will be recalled that the previous discussion of life-zones was based on the work of Cary (1911), and that Merriam's theoretical framework for the life-zones was considered specious. Nevertheless, life-zones are roughly indicative of altitudinal ecological zonation. The heterogeneity of the Upper Sonoran Zone was emphasized previously, as was the relative uniformity of higher life-zones, particularly the Canadian and Hudsonian. Previous conclusions are re-emphasized in contrasting life-zones and faunal elements.

All areographic faunal elements participate to some degree in the mammalian fauna of the Upper Sonoran Zone. The 15 species comprising the Eastern, Neotropical, and Yuman elements are restricted to the Upper Sonoran (Table 32). The great majority of Campestrian and Chihuahuan species occurs in the Upper Sonoran, and many kinds are restricted to the zone.

The Transition Zone appears as a buffer in figure 131. Relative to the Upper Sonoran, the percentage contribution of Campestrian and Chihuahuan species is decreased, whereas that of Cordilleran and Boreo-Cordilleran kinds increases markedly.

Between Transition and Canadian zones,

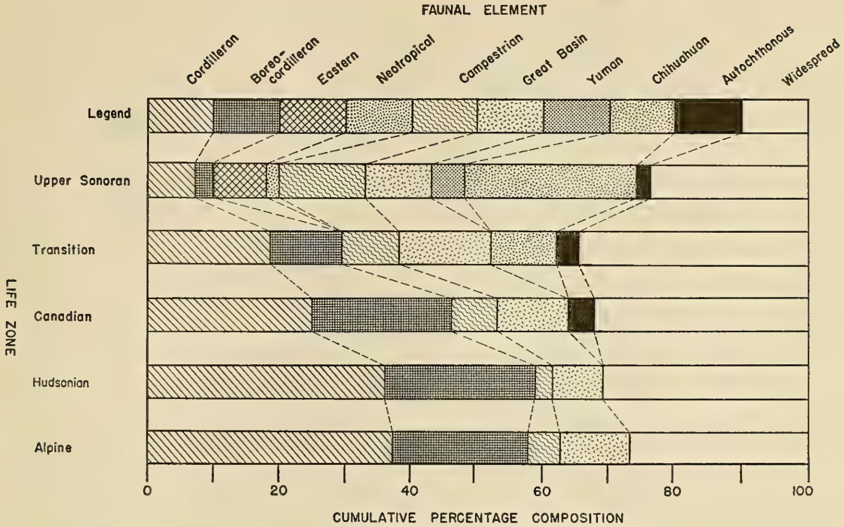

FIG. 131. Cumulative percentage composition of mammalian component of Coloradan life-zones attributable to each areographic faunal element.

Chihuahuan species drop out, and highland kinds, especially those of the Boreo-cordilleran element, evince a concomitant increase in importance. The coniferous forest "closes up" at the interface between Transition and Canadian life-zones. The Canadian and Hudsonian zones differ in the general absence of the Autochthonous Coloradan element in the higher zone and the proportionally greater importance of Cordilleran species there. As regards actual species composition, the Cordilleran fauna of the two zones is the same. Some Boreo-cordilleran species typically are absent from the Hudsonian Zone, however.

The Alpine Zone compares closely with the Hudsonian in species composition, a fact consistent with the observation made earlier

TABLE 32

Percentage of species of each areographic faunal element prevalent in a given Coloradan life-zone.

Life-zone (and number of species)	Cordilleran	Boreo-cordilleran	Eastern	Neotropical	Campestrian	Great Basin	Yuman	Chihuahuan	Autochthonous Coloradan	Widespread
Upper Sonoran (97)	42.8	23.1	100.	100.	92.8	100.	100.	92.8	100.	96.3
Transition (63)	85.7	61.5	—	—	42.8	100.	—	25.0	100.	92.6
Canadian (53)	92.8	92.3	—	—	28.6	60.0	—	—	100.	70.4
Hudsonian (39)	92.8	69.2	—	—	7.1	30.0	—	—	—	48.1
Alpine (17)	42.8	30.8	—	—	7.1	20.0	—	—	—	22.2

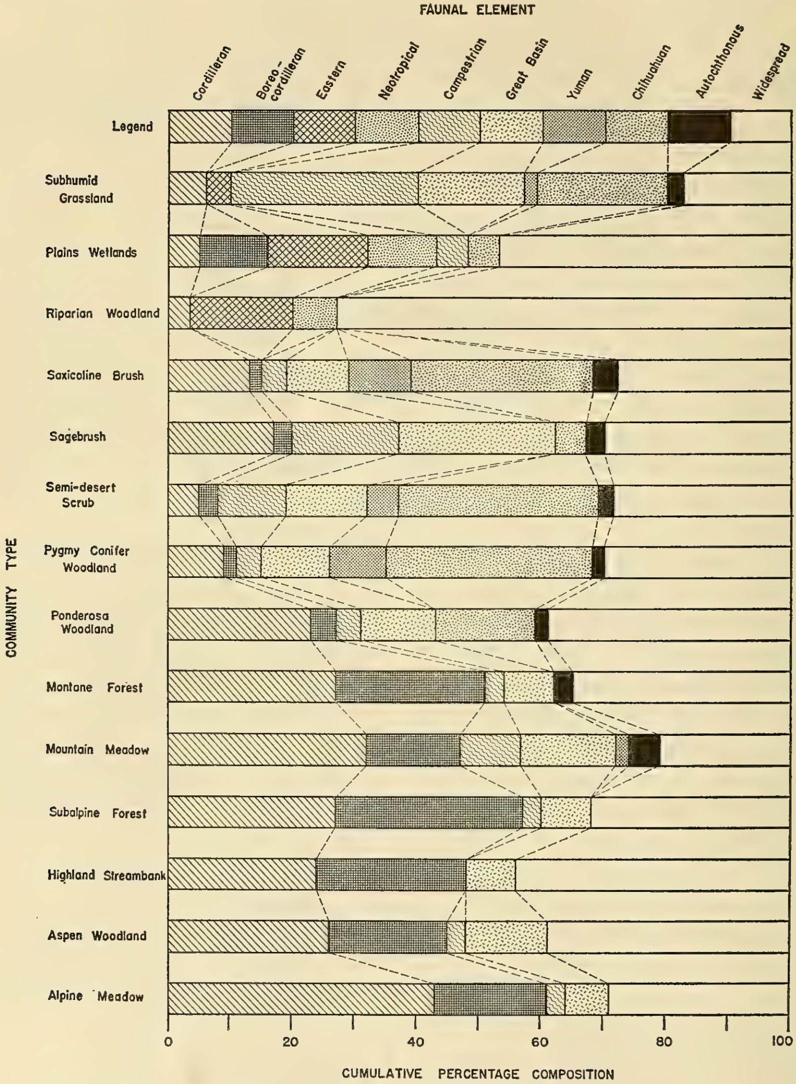

FIG. 132. Cumulative percentage composition of mammalian component of Coloradan community-types attributable to each areographic faunal element.

that no species is restricted to the Coloradan alpine. The fauna of the Alpine Zone is seen to consist of similar proportions of Cordilleran, Boreo-cordilleran, and widespread mammals, with a lesser proportion of Campestrian and Great Basin species.

Cumulative percentage composition of the mammalian fauna of 14 major community-types by representatives of distinctive areographic faunal elements is shown in figure 132. The diagram relates two disparate sorts of biogeographic entities: units based on ecology with minimal regard for geography, and units based strictly on geographic peculiarities of the ranges of species.

The Eastern Faunal Element occurs in Colorado mostly in the two mesic community-types of the eastern plains—plains wetlands and riparian woodland. The two species of the Neotropical element have the same restriction. Generally-adapted eurychores make up over 70 per cent of the mammalian fauna of deciduous woodlands of the plains and nearly half of the fauna of wetlands. Subhumid grasslands stand in marked contrast to adjacent mesic communities. As would be expected, the Campestrian Faunal Element predominates on the dry grassland, but some xeric-adapted species of other elements also find conditions there suitable. Widespread species comprise a lesser proportion of the grassland fauna than of any other major community-type. Subhumid grassland is a harsh environment in which specialists predominate.

Foothills community-types support mammalian faunas in which the Chihuahuan element is predominant. Saxicoline brush and semidesert scrub constitute plant communities of closely comparable physiognomy, occurring on quite different kinds of terrain. The elemental composition of mammalian faunas of the two community-types is quite similar. Pygmy conifer woodland is comparable to the foregoing brush communities in its mammalian fauna. Sagebrush stands, on the other hand, show a contrasting faunal composition. The proportional contribution of eurychores is similar, but Great Basin, rather than Chihuahuan, species are predominant among the distinctive theriofaunal elements. Yuman mammals are of no importance. Sagebrush communities are similar in physiognomy to other brushlands, but the stands reflect cold-desert conditions. Therefore, they support a characteristic mammalian fauna with a distinctive adaptive history.

Ponderosa woodland provides habitat for a mammalian assemblage that is, in a sense, transitional between those of dry valleys and foothills and those more typical of highland community-types. Widespread species are proportionally more important than in drier communities, and Cordilleran mammals make up a significant part of the fauna. Chihuahuan species also are present, however. In the closed forests of higher elevations and more favorable sites, those kinds generally do not occur. Conspicuously absent in the ponderosa woodland is any strong representation of Boreo-cordilleran species.

Highland community-types differ in proportional composition but generally are made up mostly of species of Cordilleran and Boreo-cordilleran affinities and of widespread species. Great Basin mammals consistently provide the most conspicuous minor element. Montane and subalpine forests are more closely comparable in faunal composition than any other pair of Coloradan community-types, and aspen woodland bears a close resemblance to those two coniferous forest communities. Mountain meadows differ from the foregoing associations in the proportionally greater importance of open-country species of the Great Basin and Campestrian elements.

The alpine community-type is remarkable in the strong predominance of Cordilleran over Boreo-cordilleran mammals. A somewhat similar predominance was noted above in discussing ponderosa woodland, and also is seen in mountain meadows. The fact corresponds with a generalization offered previously. Boreo-cordilleran mammals have more restrictive adaptations to forested sites than do Cordilleran species and have, therefore, less ecological latitude.

Contrasting highland community-types, eurychores are of greatest proportional importance in streambank and shoreline communities. Likewise, widespread species were of greatest significance in mesic associations at lower elevations. A number of species with wide geographic ranges have quite narrow ecological requirements. This is particu-

TABLE 33

Percentage of species of each areographic faunal element prevalent in a given Coloradan community-type.

Faunal element (and number of species)	Sub-humid grass-land	Plains wet-lands	Plains riparian wood-land	Saxico-line brush	Sage-brush	Semi-desert scrub	Pygmy conifer wood-land	Ponderosa pine wood-land	Mon-tane forest	Montane and sub-alpine meadow	Sub-alpine forest	High-land stream-bank	Aspen wood-land	Alpine meadow and fellfield
Cordilleran (14)	21.4	7.1	7.1	50.0	42.8	14.3	35.7	71.4	71.4	92.8	71.4	42.8	57.1	85.7
Boreo-cordilleran (13)	-----	15.4	-----	7.7	7.7	7.7	7.7	15.4	69.2	46.2	84.6	46.2	46.2	38.5
Eastern (8)	25.0	37.5	62.5	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Neotropical (2)	-----	100.	100.	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Campestrian (14)	100.	7.1	-----	14.3	42.8	28.6	14.3	14.3	7.1	28.6	7.1	-----	7.1	7.1
Great Basin (10)	80.0	-----	-----	50.0	90.0	50.0	60.0	50.0	30.0	60.0	30.0	20.0	40.0	20.0
Yuman (5)	20.0	-----	-----	100.	-----	40.0	100.	-----	-----	20.0	-----	-----	-----	-----
Chihuahuan (28)	35.7	3.6	-----	53.6	7.1	42.8	64.3	25.0	-----	-----	-----	-----	-----	-----
Autochthonous (2)	50.0	-----	-----	100.	50.0	50.0	50.0	50.0	50.0	100.	-----	-----	-----	-----
Widespread (27)	40.7	37.0	81.5	59.2	44.4	44.4	66.7	66.7	51.9	37.0	48.1	44.4	48.1	33.3

larly true of semiaquatic mammals (beaver, muskrat, mink, otter).

The percentage of each areographic theriofaunal element that is prevalent in each major community-type is shown in table 33. The data are inherent in figure 132, of course, but absolute values are grossly distorted in the figure by differences in faunal size. A number of points of interest consonant with the preceding analysis are apparent from examination of the table.

Most species (80 per cent or more) of the Cordilleran Faunal Element occur in montane, subalpine, and alpine meadows. The Boreo-cordilleran element, by contrast, is most prevalent in montane and subalpine forest. Occurrence of such species in open situations is less than 50 per cent, again stressing the trend pointed out above that Boreo-cordilleran mammals of Colorado are a stenoecious assemblage. The tendency would be accentuated were *Eutamias minimus* assigned to the Cordilleran element on the basis of historical considerations, rather than to the Boreo-cordilleran fauna on strictly geographic grounds.

Eastern and Neotropical elements are restricted to community-types typical of the Great Plains and are most characteristic of mesic situations. On the other hand, the entire Campestrian Faunal Element occurs on subhumid grassland, but is of restricted occurrence in other plains community-types.

The Great Basin Faunal Element occurs most generally in sagebrush and grassland communities, as would be expected. The close coincidence of Campestrian and Great Basin faunal elements with subhumid grassland and sagebrush community-types, respectively, is worthy of brief comment. The concordance is indicative of the presence in the definitions of those community-types of an inadvertent geographic bias. Such communities characterize rather circumscribed parts of the state, whereas a community-type like saxicoline brush is widespread. To approximate a strictly ecological definition of community-types, one probably would have to resort to purely physiognomic classification. Such a system would simplify the analysis and result in an appreciable loss of information, and it seems to me preferable in this instance to allow some latitude in definition.

The Yuman Faunal Element is most characteristic of saxicoline brush and pygmy conifer woodland. The Chihuahuan element, while more widely prevalent than the Yuman, is best represented in those two communities and in the semidesert scrub association. Neither element is significant in the sagebrush community-type, a fact that re-emphasizes the dissimilar ecology of communities of similar physiognomy.

Cumulative percentage composition of mammalian distributional areas by representatives of the several theriofaunal elements is shown in figure 133. The percentage of members of each faunal element occurring in a given distributional area is given in table 34. Whereas distributional areas were derived by an analysis that disregarded widespread and poorly known species, such kinds were included in the present tabulation. In compiling faunal lists for each distributional area, the strict protocol utilized in ecogeographic analysis was relaxed, and a species was considered to occur in a given area if a major part of its Coloradan range was in that area.

Close correspondence should be expected between distributional areas and areographic faunal elements, because distributional areas have an overt geographic component in their definition. Such close correspondence is, in fact, the case.

An obvious feature of figure 133 is the proportional contribution of widespread species to each distributional area. Of course, this merely indicates that eurychores are indeed generally distributed in Colorado, and that they might well have been omitted from consideration. They are included to make analogous figures in this section more readily comparable.

Considering only patterns of occurrence of distinctive aerographic elements, several notable features emerge. Gross overall patterns are those to be expected. Cordilleran and Boreo-cordilleran species are of greatest importance in the Rocky Mountain Faunal Area. All species of both elements occur in the area. Cordilleran species are—as one would expect from previous discussion—more prevalent in peripheral ecogeographic units than are Boreo-cordilleran kinds.

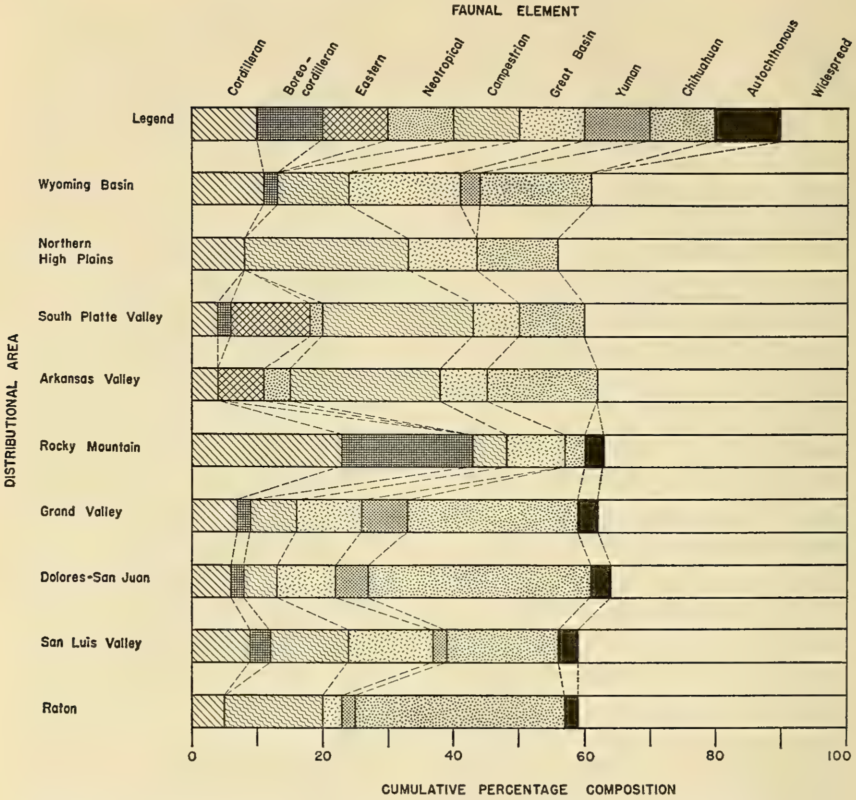

FIG. 133. Cumulative percentage composition of mammalian distributional areas attributable to each areographic faunal element.

The Campestrian element predominates in three of four Great Plains faunal districts. Eastern and Neotropical elements are present only in the South Platte and Arkansas Valley faunal districts. The Eastern element is more important in the former district than in the latter, but Chihuahuan species are more prominent in the Arkansas drainage.

In the Colorado Plateau Faunal Area and the Raton Faunal District, Chihuahuan and Yuman elements have their greatest importance. The former element is prevalent in each distributional unit, although of minimal importance in the Rocky Mountain Faunal Area.

San Luis Valley and Wyoming Basin faunal units are comparable in having no clearly predominant faunal element. In the case of the San Luis Valley, this seems to me to reflect the derived nature of the faunal assemblage, with xeric-adapted species of diverse affinities accruing to a specialized and distinctive local fauna. In the Wyoming Basin, on the other hand, one would imagine *a priori* that Great Basin and (to a lesser extent) Campestrian species should predominate. The

TABLE 34

Percentage of members of each areographic faunal element occurring in a given mammalian distributional area.

Mammalian Distributional Area	Cordilleran	Boreocordilleran	Eastern	Neotropical	Campestrian	Great Basin	Yuman	Chihuahuan	Autochthonous Coloradan	Widespread
Wyoming Basin	42.1	7.7	—	—	50.0	100.	40.0	35.7	—	92.6
Northern High Plains	21.4	—	—	—	85.7	50.0	—	17.8	—	81.5
South Platte Valley	7.1	7.7	87.5	50.0	92.8	40.0	—	14.3	—	88.9
Arkansas Valley	7.1	—	50.0	100.	92.8	40.0	—	14.3	—	85.2
Rocky Mountain	100.	100.	—	—	21.4	60.0	—	21.4	100.	92.6
Grand Valley	21.4	7.7	—	—	28.6	60.0	80.0	21.4	100.	92.6
Dolores-San Juan	21.4	7.7	—	—	21.4	60.0	60.0	21.4	100.	92.6
San Luis Valley	28.5	15.4	—	—	50.0	70.0	20.0	25.0	100.	92.6
Raton	14.3	—	—	—	64.3	20.0	20.0	7.1	50.0	96.3

observed situation seems to be a function of two factors. In the first place, the contributing elements are of widely different sizes. The absolute contribution of Great Basin and Chihuahuan elements is identical—10 species—but includes the entire Great Basin element and only about 36 per cent of Chihuahuan kinds. Furthermore, it was indicated earlier that the Wyoming Basin Faunal Area might prove subdivisable were extreme northwestern Colorado better known mammalogically. Segregation of basin and canyonland districts within the area probably would tend to create subunits of more distinctive elemental composition.

PATTERNS OF INFRASPECIFIC VARIATION

It was emphasized previously that subspecies are geographic entities. It follows that a study of patterns of distribution of distinctive infraspecific populations is of zoogeographic interest. Recurrent patterns of variation frequently illustrate convergent evolution of dissimilar taxa in response to the environment of a given area. Such convergence lends credence to the notion that mammalian distributional areas and analogous units of ecogeographic analysis are, in fact, centers of microevolution, occupied by faunas of diverse origin but subject to a common selective regime. Perhaps of greater interest is the fact that differential evolution of parts of a faunal assemblage may even provide a crude relative chronology of ecological change.

Incidence of Subspeciation

Of native Coloradan mammals, 50 species (43.5 per cent of the fauna) are represented in the state by more than a single subspecies. Only four kinds (*Sorex nanus, Lasionycteris noctivagans, Cynomys leucurus, Mustela nigripes*), however, currently are recognized as monotypic over their ranges. Species with the most subspecies recognized in Colorado are the geomyoid rodents *Thomomys talpoides* (nine), *Dipodomys ordii* (eight), and *Thomomys bottae* (six). Both *Spermophilus tridecemlineatus* and *Eutamias minimus* have four Coloradan races. Eighteen species are divisible into three subspecies each, and in 27 species, two subspecies are recognized.

The distribution by areographic theriofaunal element of the 50 species that are polytypic within Colorado is shown in table 35. The percentage of species of a given element that is polytypic within the state is indicated in the far right-hand column. Aside from the two possibly autochthonous species, the highest incidence of subspeciation in Coloradan mammals is within the 26 widespread species (more than 57 per cent). Cordilleran kinds evince considerably more subspeciation than

TABLE 35

Distribution by faunal element of 50 species polytypic in Colorado.

Faunal element	Subspecies per species 2	3	4	>5	Members of element polytypic in Colorado Total	Percentage
Cordilleran	2	3	0	1	6	42.8
Boreo-cordilleran	1	1	1	0	3	23.1
Eastern	2	0	0	0	2	25.0
Neotropical	0	0	0	0	0	00.0
Campestrian	5	0	1	0	6	42.8
Great Basin	3	0	0	0	3	30.0
Yuman	1	0	0	1	2	40.0
Chihuahuan	6	6	0	1	13	46.4
Autochthonous Coloradan	2	0	0	0	2	100.0
Widespread	7	8	0	0	15	55.5
TOTALS	29[a]	18	2	3	52[a]	

[a] Includes two species tallied in both Campestrian and Great Basin elements.

do Boreo-cordilleran species. The Boreo-cordilleran species with four races is, of course, *Eutamias minimus*.

Recurrent Modes of Variation

Recurrence of comparable modes of variation reflects a common set of selective forces affecting different species in a convergent fashion. Within some distributional patterns, coincidence of modes of geographic variation is marked, an apparent product of strict selection for particular kinds of adaptation. Convergent variation is a widespread phenomenon and has been generalized in the form of "ecogeographical rules" (see Mayr, 1965:318-327, for an excellent summary of these generalizations). Although ecogeographic rules generally are derived from continental patterns of variation, they are to be observed to some extent in an area the size of Colorado.

Gloger's rule states that "races in warm and humid areas are more heavily pigmented than those in cool and dry areas" (Mayr, 1965:667). No part of Colorado is "warm and humid," of course, but forested highlands tend to be more humid and more equable than the eastern plains or western valleys. It is in the mesic communities of the mountains that richly colored kinds are prevalent, and the best illustrations of Gloger's rule are among those species with highland and lowland races (see beyond). In 16 of 17 species exemplary of that pattern of variation, the highland subspecies is darker in color than the lowland race.

A striking example of Gloger's rule in microgeographic variation is apparent in *Spermophilus tridecemlineatus* in Colorado and adjacent states. Semi-isolated populations in montane grasslands tend to be markedly darker in color than populations of adjacent lowland habitats (see Armstrong, 1971b). The example also makes it apparent that some important patterns of infraspecific variation are not formalized in trinomial nomenclature, and that there are instances, particularly those of a local nature, in which such formal recognition is to be discouraged.

Within other patterns of subspecific differentiation, the operation of Gloger's rule is not so strikingly apparent. For the most part, other patterns include species with geographically disjunct but ecologically comparable subspecies. Within those species with eastern and western races, the eastern subspecies is paler in eight cases, and the western race is paler in eight instances. No trend is seen in density of pigmentation within other patterns of subspeciation.

Bergmann's rule holds that "races from cooler climates tend to be larger in species of warm-blooded vertebrates than races of the same species living in warmer climates" (Mayr, 1965:319). Allen's rule is essentially a correlate of Bergmann's rule, for it too involves temperature effects and body size. It states that ". . . in warm-blooded animals protruding body parts . . . are shorter in cooler climates than in warmer climates."

Coincidence of variation exemplary of Bergmann's rule is present among Coloradan mammals, but such evidence is less striking than that supporting Gloger's rule. Among the 17 species with eastern and western races, 10 pairs differ notably in overall size; in seven pairs the eastern kind is larger. As a generalization, it may be said that eastern Colorado has a colder, more continental climate than do areas of comparably low elevation on the Western Slope.

Seventeen species have distinctive highland and lowland subspecies. Within 16 pairs, there is a noteworthy difference in size; in 12 pairs it is the highland subspecies that is the larger. In eight pairs of north-south subspecies that show appreciable differences in size, the northern kind is the larger in five instances.

Of the three ecogeographic generalizations mentioned above, Allen's rule is the least applicable to mammals within Colorado. Within species, variation in size of extremities is generally slight, of a magnitude readily obscured by errors in measurement. The best examples of Allen's rule seem to me to be in contrasts of lengths of ear between mammals of arid southwestern Colorado and related kinds elsewhere. The ear of *Vulpes macrotis*, for example, is markedly longer than that of the closely related species *Vulpes velox*. A similar trend toward relatively large ears is to be seen in southwestern races of such species as *Reithrodontomys megalotis*, *Peromyscus maniculatus*, *Onychomys leucogaster*, and *Neotoma cinerea*.

Populations representing "natural areas" within the state may exhibit trends toward convergence in patterns of variation, particularly in color of pelage, thus illustrating the operation of the "ecogeographical rules," and corroborating the recognition of the areas as natural units. In the Wyoming Basin, for example, the trend is toward pallid coloration. Characteristic mammalian subspecies there include *Sylvilagus nuttallii grangeri*, *Eutamias minimus minimus*, *Spermophilus lateralis wortmani*, *Spermophilus tridecemlineatus parvus*, *Thomomys talpoides ocius*, *Perognathus fasciatus callistus*, *Dipodomys ordii priscus*, *Peromyscus maniculatus nebrascensis*, and *Neotoma cinerea arizonae*. In each case these races are paler in color than those of adjacent areas.

In the San Luis Valley, two trends are in evidence. On the one hand, *Eutamias minimus caryi*, *Spermophilus tridecemlineatus blanca*, and *Thomomys talpoides agrestis* are paler than adjacent races. On the other hand, *Perognathus flavus sanluisi*, *Perognathus apache relictus*, and *Dipodomys ordii montanus* are more richly colored (more heavily overlaid with blackish hairs) than are their counterparts in other areas.

In the southwestern part of the state, the Dolores-San Juan Faunal District, pinkish to reddish-colored subspecies prevail. Among them are *Eutamias quadrivittatus hopiensis*, *Spermophilus spilosoma cryptospilotus*, *Cynomys gunnisoni zuniensis*, *Thomomys bottae aureus*, *Neotoma cinerea arizonae*, and *Taxidea taxus berlandieri*. *Peromyscus maniculatus rufinus* occurs there in the rufous pelage typical of that race as it occurs in highland areas to the southwest. Doubtless the widespread occurrence of reddish soils in southwestern Colorado and adjacent areas has been of importance to the evolution of the distinctive color of these races.

Convergent variation within local faunas is of interest because it re-emphasizes the fact that mammalian distributional areas and analogous units are "natural areas," imposing peculiar stresses on the local fauna that select for recurrent adaptation. The overall pattern of distribution of subspecies is a datum basic to historical considerations beyond.

HISTORICAL DISTRIBUTION

Given the gross perturbations of ecological conditions associated with the Pleistocene, it is axiomatic that modern patterns of mammalian distribution have evolved since that time. Furthermore, it is apparent that most extant subspecies of mammals have differentiated since late Pleistocene times, for otherwise their close correspondence with the ecological pattern of the Recent landscape is inexplicable (see Findley and Anderson, 1956: 80). It follows that the differentiation and distribution of populations may reflect the post-glacial ecological history of an area. This proposition involves two assumptions. First, one must assume that species populations of the past reacted to environmental conditions as do their immediate, extant, descendents. In addition, the assumption is made that rates of differentiation in different species are of roughly the same order of magnitude. Neither of these assumptions is necessarily true. The latter, in fact, is sufficiently vulnerable that it usually is made tacitly. Nonetheless, both assumptions underlie the historical speculation to follow.

To say that modern patterns of distribution have evolved since late Pinedale times should not be taken to imply that the area of Colorado has at any time been *tabula rasa* with regard to mammalian life. I visualize late Pleistocene distributions as having laid the foundation of the extant Coloradan fauna. Of that basal "faunal stratum," some species remain, whereas Coloradan populations of others have become extinct. Post-glacial ecological change has altered faunal composition by allowing access of more recent faunal strata to the state, in addition to—or at the expense of—previously resident species.

Historical Implications of Patterns of Differentiation

Patterns of subspeciation within Colorado tend to fall into six general categories: 1) species with eastern and western subspecies; 2) species with highland and lowland (or, perhaps more accurately, forest or woodland and open-country) subspecies; 3) species with northern and southern subspecies; 4) species with relict races; 5) species with distinctive races in semi-isolated valleys; 6) species with insular races. Within a given species, a combination of these simple patterns may prevail.

The first pattern is exhibited by 17 species, 10 of which (see p. 359) represent the Chihuahuan Faunal Element. Of such eastern-western subspecies pairs, only two, *Lepus townsendii* and *Eutamias minimus*, show evidence of intergradation in Colorado, in both cases along the Continental Divide. The mountains are a weak barrier to movement of these two species today, but the barrier must have been stronger in the past to allow the evolution of the distinctive races.

Other kinds involved in the pattern typically are lowland species absolutely divided in the state by the Rocky Mountains. These species are components of apparently intrusive faunas east and west of the mountain core. Findley and Traut (1970) suggested a pattern of historical isolation underlying this mode of subspeciation. In some instances, the species have established secondary contact through the Wyoming Basin, but in many cases they have not. Southern species that do move through the Central Portal Faunal Area (of Long, 1965:729) in Wyoming are species of open situations (*Dipodomys ordii, Sylvilagus audubonii*) rather than saxicolous kinds. In general, Chihuahuan kinds of rough, brushy situations do not occur north into Wyoming on the Eastern Slope (see ecological discussion of the Chihuahuan Intrusive, p. 359), although some do on the Western Slope along the Green River and its tributaries. That the warmth-adapted Chihuahuan Intrusive once extended farther north along the mountain front is indicated by the presence of remains of *Myotis thysanodes* and *Spermophilus variegatus* in Little Box Elder Cave, Converse Co., Wyoming (E. Anderson, 1968:11).

Included in the east-west pattern for want of a more appropriate category are subspecies of *Lynx rufus* and *Spilogale putorius*. Both species are widespread and have distinctive geographic races in the eastern foothills and along the eastern boundary of the state. Free range for either species is precluded by generally featureless plains, and that situation must have been accentuated in any former, drier period.

The pattern of highland-lowland subspecies (category 2 above), involves some 17 species, 11 of which are eurychores and none of which are of obvious southern affinities. In such species, the lowland race may occur on the eastern plains or in one or another valley or basin of the Western Slope. The two possible Coloradan autochthons, *Eutamias quadrivittatus* and *Cynomys gunnisoni,* show this pattern of differentiation. *Sylvilagus nuttallii, Spermophilus lateralis,* and *Eutamias minimus* each have a widespread montane race and a distinctive race in the Wyoming Basin. Among widespread species, the most common model is differentiation of campestrian and montane subspecies, the latter occurring also at lower elevations on the Western Slope. In some species, there is evidence of differentation of lowland subspecies in the southwestern (*Erethizon dorsatum, Canis latrans, Taxidea taxus*) or southeastern (*Mustela frenata*) parts of the state.

The historical implications of this pattern of subspeciation are diverse. The interposition of heavy forest between parts of ancestral populations of *Eutamias quadrivittatus* and *Cynomys gunnisoni* could have constituted a significant barrier to dispersal. The subspecies in question are quite distinctive, however, and I incline to the hypothesis of an absolute glacial and forested barrier between them in Colorado, with independent evolution in two separate and distinctive refugia. *Cynomys gunnisoni zuniensis* may have evolved in semiarid grasslands to the southwest of the San Juan Mountains at a time when *C. g. gunnisoni* was adapting to cooler situations, perhaps in the San Luis Valley. Similarly, *Eutamias quadrivittatus hopiensis* may have developed its distinctive characteristics in rocky situations in the Southwest, whereas *E. q. quadrivittatus* evolved in woodlands to the east of a glacial barrier, perhaps in the Raton Section.

Eurychores with present highland and lowland races may represent a roughly comparable instance. The highland races may have evolved in forests and woodlands of western uplands, whereas the present-day lowland kinds were occupants of a much narrower band of forest in the east or of savanna and mesic grassland on the plains. The presence of distinctive southwestern races in several instances is closely analogous to the situation seen in the two supposed autochthonous species.

A pattern of north-south differentiation is seen both on the eastern plains and in the mountains, and involves 10 species. On the plains, species of the Eastern Element are restricted to major valleys and intergradation between races does not occur in Colorado. Campestrian species, on the other hand, tend to intergrade across the Platte-Arkansas Divide, or to vary clinally. Eastern species generally occur in Colorado as riparian inintrusives. Such species are susceptible to changes in distribution with minor climatic fluctuation. With drying beyond the present-day situation, such species could be removed from the Coloradan fauna. Clinal variation and intergradation across the Platte-Arkansas Divide may reflect changes in a barrier that in moister times was covered with montane woodland. In fact, however, the divide still constitutes a relatively effective barrier to general distribution, particularly for arenicolous burrowing species (see accounts of *Spermophilus tridecemlineatus, Geomys bursarius,* and *Dipodomys ordii*).

In the mountains, three kinds of voles (*Clethrionomys gapperi, Microtus pennsylvanicus, Microtus montanus*) show north-south subspeciation, but in no case are the races well marked. These distributions are considered misplaced instances of relict or insular distributions as discussed beyond at some length.

Distinction between relict subspecies and races of semi-isolated valleys as two discrete patterns of subspeciation is tenuous and largely a question of degree. Relict populations of rodents characterize the San Luis Valley and, to a lesser extent, the Arkansas Valley above Florence. A poorly marked, but apparently relict, race of *Microtus pennsylvanicus* occurs in the Republican drainage of eastern Yuma County and adjacent Nebraska, paralleling in part the distribution of a relict population of *Synaptomys cooperi* in the area (see p. 312). Species with relict distributions represent a number of areographic elements.

Microsorex hoyi is thought to exist as a relict population in north-central Colorado and adjacent Wyoming. The nearest known highland populations are in northwestern Montana. If the species is, in fact, absent from the intervening area, it must have become extinct there following dispersal over a previously widely suitable corridor. The pygmy shrew is an enigmatic instance of a more general pattern of insular montane distribution discussed below.

Zapus hudsonius is so distributed in Colorado as to suggest a formerly wider range there; a relict population occurs along the mountain front in the north-central part of the state. *Microtus pennsylvanicus uligocola* has a distribution on the plains roughly analogous to that of *Z. hudsonius,* but occurs in mountain meadows as well over a restricted area. A second subspecies of the meadow vole is centered in south-central Colorado. Both *Zapus hudsonius* and *Microtus pennsylvanicus* are species of meadows. Their relict occurrence along the mountain front suggests the former occurrence of humid grassland or savanna in eastern Colorado. *Cryptotis parva* is a third species that possibly reflects this pattern, although the least shrew may have come to occur along the mountain front only relatively recently.

Distinctive populations of the San Luis Valley suggest no single ecological trend. Montane species, grassland kinds, and mammals of more arid situations all have evolved distinctive races in the valley. The presence of races of montane species on the floor of a semidesert valley may reflect a time when the valley floor was more suitable habitat than were the adjacent mountains. The subspecies represent adaptable, euryecious species and may have responded *in situ* apace with gradual vegetational change. The fact that xeric-adapted kinds are semi-isolated in the San Luis Valley suggests a time when coniferous woodland was less prevalent in the middle Rio Grande Valley than it is today. *Microtus pennsylvanicus modestus* is so distributed as to suggest a race autochthonous in the San Luis Valley and of secondary occurrence in meadows of the surrounding mountains. Its presence about springs and shallow lakes in an otherwise arid valley would seem to indicate that mesic conditions formerly were typical of the area. Further, the possibility of a formerly suitable corridor for dispersal from the north and east is suggested, although the presence of populations in northern New Mexico indicates that this need not necessarily have been the case.

The distinctive grassland and shrubland fauna of the Upper Arkansas Valley includes an endemic subspecies of *Dipodomys ordii* and semi-isolated populations of *Spermophilus tridecemlineatus, Perognathus flavus,* and *Onychomys leucogaster.* The presence of such species suggests a former semiarid grassland corridor. Neither the immediate valley of the Arkansas nor the Wet Mountain Valley supports continuous habitat for such a fauna at present. Whether initial access for the fauna to the Upper Arkansas Valley was via the Wet Mountain Valley or via a route following the Arkansas and circumventing Royal Gorge is a matter for speculation. The nearly continuous distribution of *Thomomys bottae internatus* through the Wet Mountain Valley and the presence of that same subspecies in the Upper Arkansas Valley suggests a route across Promentory Divide and the Wet Mountain Valley as the more likely. On the other hand, there is a strong possibility of communication with the San Luis Valley over Poncha Pass. Seemingly, a slight shift to aridity would open that area as a corridor. The resemblance of specimens of *Perognathus flavus bunkeri* from Chaffee County to individuals of *Perognathus flavus sanluisi* suggests such a route of distribution, as does the resemblance of *Dipodomys ordii evexus* to *Dipodomys ordii montanus* of the San Luis Valley. Whether these resemblances are convergent is, of course, not known. Any or all of the above routes may have allowed access of open-country mammals to the Upper Arkansas Valley and obviously that area presents an interesting focus for further study.

Semi-isolation of populations in and along valleys of the Western Slope is a distributional pattern recurrent in seven species of southern affinities. The best illustration is *Dipodomys ordii,* where distinctive races occupy suitable habitat in the San Juan, San Miguel, Colorado, and Yampa-White watersheds. Less extensive differentiation of a comparable sort is seen in *Ammospermophilus leucurus, Thomomys bottae, Perognathus apache, Neotoma albigula,* and *Vulpes macrotis.* The occurrence of this pattern would seem to reflect a past period in which peninsular corridors of woodland were of less importance as barriers than they are today.

Insular patterns of subspeciation occur in three Cordilleran species, *Ochotona princeps, Marmota flaviventris,* and *Thomomys talpoides.* In the case of the northern pocket gopher, the pattern is relatively complex. The other two species, however, are not greatly discordant in pattern with north-south subspecies pairs seen in the voles *Clethrionomys gapperi, Microtus montanus,* and *Microtus pennsylvanicus.* Only in *Thomomys talpoides* are the subspecies markedly distinct, and communication between named populations seems to be intermittently possible today (except perhaps in the case of the meadow vole). The presence of weakly marked races in highland species seems to reflect a period in which the isolating effect of major valleys was accentuated by drying and a consequent movement upslope of ecological zones. With a return to slightly more mesic conditions genetic exchange between populations generally has been re-established. Aside from the evidence offered by this pattern, the mountains of Colorado are poorly suited to preserving a record of environmental change. Within the state, the mountainous core is essentially continuous. Peripheral peaks and ranges are at most semi-isolated from the continuous core. Ranges large enough to support a balanced fauna (the Wet Mountains, for example) generally have been isolated insufficiently to provide the fauna with any independent evolutionary opportunity. One must look to other parts of the Rocky Mountain chain to gain an insight into the history of the highland fauna of Colorado. Zoogeographic history of the mountains of New Mexico and Arizona was outlined by Findley (1969). Hoffmann and Jones (1970) discussed zoogeographic relationships of the highland coniferous forest and the Late Pleistocene taiga of the non-glaciated Northern Great Plains.

Zoogeographic Relationships of Southern Rocky Mountains

In order to assess relationships of the mammalian faunas of the mountains of Colorado *inter se* and to faunas of the Middle Rocky Mountains, faunal lists were prepared for the Park, Front, Sawatch, San Juan, and Sangre de Cristo ranges in Colorado, for the Uinta and Wasatch mountains of Utah (after Durrant, 1952), and for the Teton and Wind River mountains and the Absaroka Range-Yellowstone Plateau in northwestern Wyoming (after Long, 1965). The lists included all species present in the mountains of northwestern Wyoming or north-central Colorado (or both), but omitted species moving freely across the intervening Wyoming Basin today. Species were ignored that I considered to be known so poorly taxonomically or distributionally that they might distort comparisons. Under the above restrictions, all species considered represent either the Cordilleran or Boreocordilleran areographic faunal elements as defined previously by me. Most species occur in and near the coniferous forests of high elevations—the Canadian and Hudsonian life-zones of Cary (1911, 1917)—or in the alpine.

A few species (including *Eutamias minimus, Spermophilus lateralis, Thomomys talpoides, Neotoma cinerea*) might have been judiciously omitted from consideration in the tabulation, for they occur in the Wyoming Basin today. In each case, however, basin populations are well differentiated from montane stocks and are (at least) subspecifically distinct from highland kinds on either side. Tabulation was at the subspecific level.

A similarity matrix of the mammalian faunas of 10 mountain ranges is given in table 36. The number of kinds present in each fauna appears in bold-face along the diagonal, absolute numbers in common appear below the diagonal, and a faunal resemblance factor (FRF) appears above the diagonal. The FRF is an index used earlier to compare life-zones and was explained in that context (see p. 321). Twenty-five species were considered in all. Obviously the number of species present declines generally from north to south. The largest highland faunas (24 species) are found in northwestern Wyoming. *Microsorex hoyi* occurs in the Park Range but is unknown in northwestern Wyoming; otherwise all species considered occur in the Teton, Absaroka, or Wind River mountains. *Eutamias amoenus* and *Spermophilus armatus* are unique to that area among the mountain ranges considered. *Glaucomys sabrinus* and *Microtus richardsoni* co-occur in the mountains of Utah and northwestern Wyoming. *Microtus pennsylvanicus* is absent in the Uinta Mountains and the Park

TABLE 36

Similarity matrix (FRF) of highland faunas of 10 ranges in Middle and Southern Rocky Mountains.
(For explanation, see text.)

Mountain range	Teton	Absaroka-Yellowstone	Wind River	Wasatch	Uinta	Park	Front	Sawatch	Sangre de Cristo	San Juan
Teton	**24**	.916	.808	.638	.533	.409	.355	.363	.293	.325
Absaroka-Yellowstone Plateau	22	**24**	.893	.553	.488	.454	.360	.409	.293	.325
Wind River	19	21	**23**	.565	.500	.465	.409	.418	.300	.333
Wasatch	15	13	13	**23**	.590	.465	.409	.418	.351	.380
Uinta	12	11	11	13	**21**	.650	.571	.584	.512	.550
Park	9	10	10	10	13	**20**	.829	.800	.594	.666
Front	8	9	9	9	12	17	**21**	.926	.631	.750
Sawatch	8	9	9	9	12	16	19	**20**	.648	.820
Sangre de Cristo	6	6	6	7	10	11	12	12	**17**	.777
San Juan	7	7	7	8	11	13	15	16	14	**19**

NUMBERS IN COMMON

FAUNAL RESEMBLANCE FACTOR

Range, but occurs in northwestern Wyoming and in parts of mountainous central Colorado.

Six subspecies are common to all ranges considered: *Sorex vagrans obscurus, Sorex palustris navigator, Lepus americanus bairdii, Phenacomys intermedius intermedius,* and *Mustela erminea muricus. Sorex cinereus cinereus* is known from all of the ranges under consideration save the Sangre de Cristos.

In general, faunal resemblances shown in table 36 are those that would be expected *a priori.* The mountains of northwestern Wyoming resemble each other as do the ranges of central Colorado. Northern and southern ranges in Colorado tend to be somewhat distinctive, but the whole of the Coloradan highland is a relatively coherent unit. The most interesting relationships in evidence in table 36 are those of the Uinta and Wasatch mountains of Utah. The Uinta Mountains relate to the Wasatch Mountains by a relatively low index (FRF=0.590), considering the fact that the ranges are separated only by the upper valleys of the Duchesne and Weber rivers. On the other hand, the Uinta Mountains and the Park Range are separated by the Green River and the open brushlands of the Yampa Basin, a broad area, most of which is unsuitable for forest-adapted mammals. However, the Uinta and Park ranges are united by a faunal resemblance factor of 0.650. In fact, the mean FRF of the Uinta Mountains to the Southern Rockies as a whole is 0.573, nearly as high as its resemblance to the adjacent Wasatch Mountains. These relationships are explicable only if the Green River and the Yampa Basin have been considerably less effective as a barrier in the past than they are today, or if taxonomic inconsistencies are affecting the zoogeographic analysis. I suspect that both historical and artifactual agents are operable in this case.

In only one instance does a subspecies occur in northwestern Wyoming and in the Park Range and not also in the Uinta Mountains. The subspecific assignment of populations of *Clethrionomys gapperi* in the area is equivocal, however (see Long, 1965:643), and may not bear directly on the problem at hand. The same nominal race of *Zapus princeps* occurs in the Bighorn Mountains and in the southern Rockies. A further suggestion of faunal relationships directly across central Wyoming is the presence of *Tamiasciurus hudsonicus baileyi* in the Bighorn Mountains and in such isolated ranges in southern Wyoming as the Ferris, Shirley, Casper, and northern Laramie mountains, southward, apparently, to Pole Mountain (Long, 1965:595; but see Hoffmann and Jones, 1970:374). In none of the above species has continuity been demonstrated between populations in north-central and south-central Wyoming, and such continuity seems to me highly unlikely.

Microtus pennsylvanicus occurs in northwestern Wyoming and in central Colorado and is absent from the Uinta Mountains. However, the distribution and ecology of the meadow vole in Colorado suggests that the species may best not be considered a truly montane mammal, but rather a species of a formerly more mesic plains grassland that occurs today in montane meadows as refugia.

In my view, there is no compelling suggestion of direct communication between montane populations across the Wyoming Basin, rather than across the Green River and the Yampa Basin. If both routes were available, the Yampa Basin corridor was the more important or the later in time, or both. Even based on current understanding of infraspecific taxonomy, all Coloradan montane mammals could have reached the Southern Rocky Mountains via the Uinta Mountains, whereas not all kinds could have been received directly from the highlands of northwestern Wyoming.

The foregoing observation is in general agreement with that of Findley and Anderson (1956:82), who concluded, in essence, that the discontinuity of boreal forest in the Yampa Basin has become an important barrier later than the discontinuity produced by dessication of the Wyoming Basin and adjacent lowlands in central Wyoming.

No consistent ecological differences are readily apparent between differentiated species and those with a single subspecies common to the Uinta and Park ranges, although there is a general trend toward the situation observed by Findley and Anderson *(loc. cit.)*. Relationships are stronger among species not restricted to closed forest, and are most pronounced in those kinds (shrews, some voles) that might utilize corridors formed along minor watercourses across open areas. Apparently such corridors have been available more recently than has an avenue of closed coniferous forest.

Historical Conclusions

The descriptive comments of the previous sections now may be considered in a more general framework. Recurrent patterns of distribution and differentiation indicate that the extant Coloradan mammalian fauna has come to occur in the state under diverse conditions and at different times. The diverse ecological conditions are reflected in different patterns of distribution representing what I shall call "accessional modes." These modes are based on broad ecological relationships and have no necessary historical integrity. Four accessional modes are apparent for components of the Coloradan fauna—basal, xeric, thermal, and hygric.

The basal accessional mode reflects a climate colder than that of the present and effectively, if not absolutely, moister. Examples of the basal mode are distributions that today are discontinuous between the Middle and Southern Rocky Mountains.

The xeric accessional mode includes distributions dependent on a climate actually or effectively drier than the present. Examples of this mode are common: xeric-adapted relicts and semi-isolated populations in the San Luis Valley, valleys of the Western Slope, and the Upper Arkansas Valley; north-south pairs of subspecies in montane voles; semi-isolated peripheral populations of grassland species in mountain parks.

A thermal accessional mode reflects a past time warmer than the present. Coloradan distributions reflect this mode only indirectly, although, if a correlate of the above-mentioned xeric mode, evidence for it is stronger. The incidence of members of the Chihuahuan Intrusive fauna in the assemblage at Little Box Elder Cave, Wyoming, prompts me to include the thermal as a distinctive accessional mode. This, in turn, assumes that the Chihuahuan Intrusive is, as I have suggested (p. 359), temperature-limited.

The hygric accessional mode suggests times past that were moister than the present. Relict populations of *Zapus hudsonius* and *Microtus pennsylvanicus* suggest the importance of this mode. Within historic time, accession in the hygric mode has been fostered in Colorado by the development of irrigated agriculture.

In general, subspeciation is common in species representing the basal mode, widespread in those of xeric and hygric modes, and minimal in distributions of the thermal mode.

Subdivision of the four so-called accessional modes may allow the identification and ordering of temporally coherent, semi-independent "accessional strata." A basal, Pinedalian faunal stratum occupied the area that now is Colorado in glacial times. A major component of the stratum was a group of mammals adapted to highland or boreal coniferous forest and to other habitats now characteristic of middle and higher elevations in Colorado. Suitable habitat for the fauna was continuous, or nearly so, across the Yampa Basin and perhaps across the lowlands of central Wyoming as well. In Colorado, the fauna—comprised primarily of Cordilleran, Boreo-cordilleran, and widespread species, must have been divided to some extent by valley glaciation and cap ice. The faunal assemblage occurred at middle elevations in the mountains, over the foothills, and eastward to the edge of the Colorado Piedmont. In the west, the fauna extended onto higher parts of the Colorado Plateau and Wyoming Basin with minimal interruption.

The eastern plains must have been an open savanna or parkland supporting a fauna of eurychores and some Campestrian species in Pinedale times. To the west of the mountains, analogously, widespread and Great Basin species predominated at lower elevations. The barrier between the Great Plains and the Wyoming Basin and Colorado Plateaus was absolute, or nearly so, during Pinedale times, for the Wyoming and Yampa basins were crossed by one or more substantial forest corridors.

Climatic change marked by the recession of Pinedale glaciers was of major ecological importance, and prompted the development of an environmental pattern perhaps not unlike that prevalent today. The montane fauna of the Southern Rocky Mountains was left as a distributional relict as ecological zonation moved upslope and corridors to the Middle Rocky Mountains were broken. Vegetational change was sufficiently slow, however, that a few Cordilleran species were able to develop *in situ* subspecies adapted to the drastically altered conditions of the Wyoming Basin *(Eutamias minimus minimus, Spermophilus lateralis wortmani, Thomomys talpoides ocius)* or the San Luis Valley *(Eutamias minimus caryi, Thomomys talpoides agrestis).*

Drying on the plains restricted habitat suitable for mesic-adapted species and may account for some relict populations of the hygric accessional mode. The meadow vole, *Microtus pennsylvanicus*, apparently was divided into northern and southern stocks at this time, invading montane meadows from grasslands of the plains *(uligocola)* or the San Luis Valley *(modestus).* On the other hand, the relict distribution of *Zapus hudsonius* in north-central Colorado may be a relict of a later hygric faunal stratum, for that population is thought to extend without subspecific differentiation to southeastern Wyoming (Long, 1965:665; but see Hoffmann and Jones, 1970: 372), although populations in the two areas almost certainly are discontinuous today.

I visualize the Platte-Arkansas Divide as having been a relatively broad woodland corridor in Pinedale times. Warming and drying with glacial retreat caused ranges of montane species to retract along the corridor. East of the vicinity of Elbert, no islands of woodland survive today that are known to support any characteristic montane mammals, although *Thomomys talpoides*—adapted not to woodland, but to montane soils—still occurs well eastward on the divide.

The Raton Section, likewise, has undergone constriction of a once widespread montane habitat. Erosion has accentuated the constriction although the area retains stronger faunal affinities with the highlands than does the Platte-Arkansas Divide. On the Western Slope, restrictions of this sort were not so marked in Colorado as they were farther west, for the highland corridors south of the White River generally have maintained their ecological integrity within the state.

The basal faunal stratum, characteristic of Late Pinedale times, retreated as montane corridors were broken. With the restriction of habitat, some species doubtless became extinct in the state, whereas other species characteristic of the western and boreal coniferous forests had not occurred in Colorado even under optimal, full-glacial conditions. Breaking corridors for the species of one stratum meant creation of corridors for the species of another

—some distributions in thermal and xeric accessional modes were made possible.

Evidence from patterns of existing distribution indicates that the most important ecological influence in Coloradan faunal history between the recession of Pinedale glaciers and the advent of permanent settlement was an interval, or intervals, of warmer temperatures and lower effective precipitation. The distributional modes that reflect these changes may have been coincident but need not have been.

In Pinedale times, a general depression of ecological zonation (relative to that seen today) must have been prevalent. A more favorable hydrographic regime characterized the foothills and I visualize forest and woodland covering these areas, thinning to savanna on the Colorado Piedmont. With drying and warming, the zones of forest moved upslope. A point was reached at which the contact between forest and grassland lay in a topographic situation unsuitable for either community-type. Characteristic shrub and pygmy-conifer communities came to occupy the lower foothills, ridges, and mesas, particularly where weathering produced topography too rough for grassland. With that gross ecological change, ecesis along the mountain front was made possible for an intrusive fauna from the south. In formerly warmer times that fauna occurred northward on the Eastern Slope to southern Wyoming.

On the plains, immediately post-glacial warming and drying changed a savanna to subhumid grassland and allowed the enrichment of the campestrian mammalian fauna by warmth-adapted species of the open country to the south. On the Western Slope, drying or warming, or both, beyond the present level allowed free access to some valleys for such species as *Dipodomys ordii* and *Thomomys bottae*. The fauna of the San Luis Valley was enriched by a number of species of desert grasslands and shrublands. The Upper Arkansas Valley came to be populated by a comparable range of species, most of which no longer enjoy free access to the valley. Furthermore, grassland species found corridors to parks at high elevations in the mountains, which presently are poor routes for continued access.

In the mountains, the isolating effect of valleys was strengthened and mountain passes were effectively lowered. Populations of *Clethrionomys gapperi* and *Microtus montanus* apparently were separated by a barrier in the vicinity of the Cochetopa Hills. Isolation of insular populations of *Ochotona princeps*, *Marmota flaviventris*, and perhaps *Thomomys talpoides* was stronger than it is today. Indeed, the same climatic fluctuations that apparently isolated populations of *Marmota flaviventris* in the Sangre de Cristo and Wet mountains may have allowed access for drought-adapted kinds to the Upper Arkansas Valley from the plains through the Wet Mountain Valley or from the San Luis Valley over Poncha Pass. The absolute magnitude of such changes can only be guessed, of course, but the change that disrupted the range of montane voles apparently was not sufficiently pervasive (or sufficiently long-lived) to provide a semidesert corridor between the San Luis Valley and the upper Gunnison Valley or, indeed, to allow Chihuahuan and Yuman mammals into the Gunnison Valley above the Black Canyon.

The available data would seem to indicate that the several mammalian distributions that share the xeric and thermal accessional modes represent at least two temporal strata, suggesting the recurrence of warm, dry conditions. Characteristic subspecies have evolved in the San Luis Valley and among valley intrusives on both the Eastern and Western slopes, but no subspeciation has occurred in the mountain parks. If these examples are, in fact, indicative of two distinctive temporal strata, distributional patterns to indicate the character of the intervening period are not apparent, and conditions may have been not unlike those of the present time.

The latest accessional stratum, most evident on the eastern plains, consists of species generally characteristic of areas warmer or more mesic than is most of eastern Colorado at present, and distributed to the east and southeast of the state. The accession of these species is an ongoing phenomenon, and represents both thermal and hygric modes. The stratum includes species that are expansive in eastern Colorado today *(Didelphis marsupialis, Sciurus niger, Sigmodon hispidus, Procyon lotor)*. The nine-banded armadillo, *Dasypus novemcinctus,* also may represent such a stratum (see p. 313). Other examples of species probably expansive locally are *Cryptotis parva, Scalopus aquaticus, Peromyscus leucopus, Microtus ochrogaster,* and *Vulpes vulpes.* The considerable range extensions of *Lepus californicus* and *Spermophilus richardsonii* in the Twentieth Century also may represent this latest stratum. Expansion of this heterogeneous assemblage of species doubtless is a response to both secular climatic change over the past century (see Hoffmann and Jones, 1970:361) and to extensive disruption of the plains environment by irrigated agriculture, impoundment of once fluviatile waters, and permanent settlement.

Summary

Evidence from patterns of distribution and differentiation of Coloradan mammals suggests colonization of the state through four distinctive accessional modes. Each mode reflects climatic conditions different from those prevalent today. Component species distributions representing different accessional modes were subdivided in an attempt to define temporally coherent faunal strata. Obviously the data set does not allow precise definition of such strata, but general trends are nonetheless suggested strongly.

A basal stratum occurred in Colorado in Pinedale times while glaciers and cap ice occupied extensive tracts in the mountains. Glacial recession allowed access to the state for some southern species and restricted the ranges of mesic-adapted kinds. Ecological zonation attained a pattern like that seen today and some intrusion of warmth-adapted saxicolous kinds was possible in canyons and along the mountain front. A period of warming or drying (or both) ensued—probably on more than a single occasion and effective to varying degrees—that fragmented ranges of some species and favored extension of others. That the present is a return to somewhat more moderate conditions is reflected in the general continuity of ranges of highland species and the contemporary narrow restriction of warmth-adapted species. Major adjustments of ranges within historic times represent an apparent final faunal stratum, influenced both by climatic change and by human intervention.

Analysis of patterns of mammalian distribution indicates the influence of millenial, secular, and short-term climatic change in post-glacial times. The most pervasive influences on composition of the Recent fauna of Colorado have been Pinedale glaciation, an interval of climates warmer and drier than the present time, and the advent of permanent agrarian, pastoral, and urban settlement.

SUMMARY AND CONCLUSIONS

Zoogeography seeks to describe and explain distributional characteristics of animals. Zoogeography is part science, part point-of-view, and part pastime. Zoogeographers produce no primary data, but draw for analysis data from various semi-independent systematic and ecological disciplines. Distributional attributes of Coloradan mammals have been viewed from ecological, ecogeographic, and areal aspects. None of these is wholly independent of the others, nor is any alone sufficient to describe all patterns of distribution adequately. In addition, each ignores a dynamic historical component, the evolution of the pattern described.

Ecological distribution was analyzed in terms of life-zones and also on the basis of community-types. Use of such categorical systems is encouraged in Colorado by the occurrence of abrupt changes in ecology in areas of high relief. The latter, less formal, analysis was seen to describe the Coloradan environmental complex more adequately than the former, more formal, one. It was concluded, however, that both systems represent an appreciable loss of information over autecological studies, for no two kinds of mammals have precisely the same ecological limits.

Insight into the complexity of the Coloradan environment was gained by brief consideration of variation in absolute density of species over the state.

Mammalian distributional areas—monothetic units analogous to biotic provinces—were used to describe patterns of ecogeographic distribution. Four major faunal areas were recognized and a number of faunal districts, each characterized by unitary local microevolutionary tendencies, were outlined.

Geographic attributes of ranges were utilized to describe patterns of areal distribution. Nine distinctive areographic theriofaunas were recognized. The differential contribution of each of these theriofaunas to the various Coloradan life-zones, community-types, and distributional areas was discussed. In general, most considerations suggested close coincidence of the areographic units with faunal strata of historical integrity.

Historical zoogeography is an attempt to understand the evolution of patterns of distribution. In the present instance, the objective was to gain some insight into gross post-glacial ecological change in Colorado. Consideration of a single group of organisms in a circumscribed geographic area, while a prudent restriction of interest, leads to partial solutions. Full coincidence of the tentative conclusions drawn here with those of studies in other disciplines is unexpected, unnecessary, and perhaps—at the present state of our knowledge—even undesirable. Seemingly perfect solutions seldom are heuristic. Only iterative synthesis of a broad range of historico-ecological studies will allow a general appreciation for the sequence and magnitude of local and regional ecological changes that have shaped existing distributional patterns, selected the adaptive constitutions of populations, and influenced the composition of communities over the complex mosaic that is the environment of Colorado.

LITERATURE CITED

Albertson, F. W., G. W. Tomanek, and A. Riegel
1957. Ecology of drought cycles and grazing intensity of grasslands of central Great Plains. Ecol. Monogr., 27:27-44.

Aldous, S. E.
1935. Some breeding notes on rodents. Jour. Mamm., 16:129-131.

Allen, G. M.
1908. Notes on Chiroptera. Bull. Mus. Comp. Zool., 52:25-62.
1916. Bats of the genus Corynorhinus. Bull. Mus. Comp. Zool., 60:331-356.

Allen, H.
1864. Monograph of the bats of North America. Smithsonian Misc. Coll., 7(165):xxiii+85.

Allen, J. A.
1872. Notes on an ornithological reconnaissance of portions of Kansas, Colorado, Wyoming, and Utah. Bull. Mus. Comp. Zool., 3:113-183.
1874. Notes on the mammals of portions of Kansas, Colorado, Wyoming, and Utah. Bull. Essex Inst., 6:43-66.
1877. History of the American bison, *Bison americanus*. Ann. Rept. U.S. Geol. and Geogr. Surv. Territories, 9:443-587.
1892. The geographical distribution of North American mammals. Bull. Amer. Mus. Nat. Hist., 4:199-243.
1893. List of mammals collected by Mr. Charles P. Rowley in the San Juan Region of Colorado, New Mexico and Utah, with descriptions of new species. Bull. Amer. Mus. Nat. Hist., 5:69-84.
1894. Descriptions of ten new North American mammals, and remarks on others. Bull. Amer. Mus. Nat. Hist., 6:317-332.
1895a. On the species of the genus Reithrodontomys. Bull. Amer. Mus. Nat. His., 7:107-143.
1895b. Descriptions of new American mammals. Bull. Amer. Mus. Nat. Hist., 7:327-340.
1896. List of mammals collected by Mr. Walter W. Granger, in New Mexico, Utah, Wyoming, and Nebraska, 1895-96, with field notes by the collector. Bull. Amer. Mus. Nat. Hist., 8:241-258.
1898. Revision of the chickarees, or North American red squirrels (subgenus Tamiasciurus). Bull. Amer. Mus. Nat. Hist., 10:249-298.
1900. Note on the wood bison. Bull. Amer. Mus. Nat. Hist., 13:63-67.
1910. [Review of] The mammals of Colorado. Science, 32 (n.s.):178-179.
1912. A new pika from Colorado. Bull. Amer. Mus. Nat. Hist., 31:103-104.

Anderson, E.
1968. Fauna of Little Box Elder Cave, Converse County, Wyoming. The Carnivora. Univ. Colorado Studies, Ser. in Earth Sci., 6:1-59.

Anderson, S.
1954. Subspeciation in the meadow mouse, Microtus montanus, in Wyoming and Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 7:489-506.
1956. Subspeciation in the meadow mouse, Microtus pennsylvanicus, in Wyoming, Colorado, and adjacent areas. Univ. Kansas Publ., Mus. Nat. Hist., 9:85-104.
1959a. Mammals of the Grand Mesa, Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 9: 405-414.
1959b. Distribution, variation, and relationships of the montane vole, Microtus montanus. Univ. Kansas Publ., Mus. Nat. Hist., 9: 415-511.
1961. Mammals of Mesa Verde National Park, Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 14:29-67.
1965. Sources of error in locality data. Syst. Zool., 14:344-346.
1966. Taxonomy of gophers, especially *Thomomys* in Chihuahua, Mexico. Syst. Zool., 15: 189-198.

Andrews, A.
1965. Bull moose southwest of Meeker. Colorado Outdoors, 14(5):15.

Anonymous.
1946. The wolverine in Colorado. Colorado Conservation Comments, 9(1):22.
1948. The white-tailed deer gone as residents of the state. Colorado Conservation Comments, 10(6):11-12.
1965. More whitetails for Colorado. Colorado Outdoors, 14(1):5.

Antevs, E.
1954. Climate of New Mexico during the last glacio-pluvial. Jour. Geol., 62:182-191.

Anthony, A. W.
1923. Periodical emigrations of mammals. Jour. Mamm., 4:60-61.

Archibold, W. S.
1964. Small mammals of a Colorado river bottom. Jour. Colorado-Wyoming Acad. Sci., 5(5):44-45.

Armitage, K. B.
1962. Social behaviour of a colony of the yellow-bellied marmot *(Marmota flaviventris)*. Anim. Behav., 10:319-331.
1965. Vernal behaviour of the yellow-bellied marmot *(Marmota flaviventris)*. Anim. Behav., 13:59-68.

Armitage, K. B., and J. F. Downhower
1970. Interment behavior in the yellow-bellied marmot *(Marmota flaviventris)*. Jour. Mamm., 51:177-178.

Armstrong, D. M.
1970. [Review of] Wild mammals of Colorado. Jour. Mamm., 51:436-437.
1971a. [Letter to editor]. Colorado Outdoors, 20 (1):48-49.

1971b. Notes on variation in *Spermophilus tridecemlineatus* (Rodentia, Sciuridae) in Colorado and adjacent states, and description of a new subspecies. Jour. Mamm., 52:528-536.

Armstrong, D. M., B. H. Banta, and E. J. Pokropus
1972. Altitudinal distribution of small mammals along a cross-sectional transect through the Arkansas River watershed, Colorado. Southwestern Nat., in press.

Armstrong, D. M., and J. K. Jones, Jr.
1971a. Sorex merriami. Mammalian Species, 2: 1-2.
1971b. Mammals from the Mexican state of Sinaloa. I. Marsupialia, Insectivora, Edentata, Lagomorpha. Jour. Mamm., 52:747-757.
1972. Notiosorex crawfordi. Mammalian Species, in press.

Audubon, J. J., and J. Bachman
1856. The quadrupeds of North America. V. G. Audubon, New York, 3 vols.

Axtell, R. W.
1962. Can we use biotic provinces? Syst. Zool., 11:93-96.

Bailey, A. M.
1937. A hoary bat family. Jour. Mamm., 18:514-515.
1940. The moose in Colorado. Jour. Mamm., 21: 96.
1944. Records of moose in Colorado. Jour. Mamm., 25:192-193.

Bailey, V.
1893. The prairie ground squirrels or spermophiles of the Mississippi Valley. Bull. Div. Ornith. and Mamm., U.S.D.A., 4:1-69.
1895. The pocket gophers of the United States. Bull. Div. Ornith. and Mamm., U.S.D.A., 5:1-47.
1897. Revision of the American voles of the genus *Evotomys*. Proc. Biol. Soc. Washington, 11:113-138.
1900. Revision of American voles of the genus Microtus. N. Amer. Fauna, 17:1-88.
1907. Wolves in relation to stock, game, and the National Forest reserves. Bull. U.S. Forest Service, 72:1-31.
1915. Revision of the pocket gophers of the genus *Thomomys*. N. Amer. Fauna, 39:1-136.
1927. Beaver habits and experiments in beaver culture. Tech. Bull., U.S.D.A., 21:1-39.
1932. Mammals of New Mexico. N. Amer. Fauna, 53:1-412.

Baird, S. F.
1855. Characteristics of some new species of North American Mammalia, collected chiefly in connection with the U.S. surveys of a railroad route to the Pacific. Proc. Acad. Nat. Sci., Philadelphia, 7:333-336.
1858. Mammals *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 8(1):xxi-xlvii+1-757.

Baker, F. S.
1944. Mountain climates of the western United States. Ecol. Monogr., 14:229-243.

Banta, B. H., and T. M. Norris
1968. The small mammal fauna sampled along a transect of prairie in El Paso, Colorado, in 1963 and 1964. Wasmann Jour. Biol., 26: 185-200.

Barbour, R. W., and W. H. Davis
1969. Bats of America. Univ. Press of Kentucky, Lexington, 286 pp.
1970. The status of *Myotis occultus*. Jour. Mamm., 51:150-151.

Bear, G. D., and R. M. Hansen
1966. Food habits, growth and reproduction of white-tailed jackrabbits in southern Colorado. Tech. Bull., Colorado State Univ. Agric. Exper. Sta., 90:vii+59.

Beck, D. E.
1966. Siphonaptera (fleas) of Mesa Verde National Park, Montezuma, Colorado. Great Basin Nat., 26:76-78.

Beckwith, E. G.
1855. Report of explorations for a route for the Pacific Railroad . . . near the 38th and 39th parallels of north latitude. Pp. 1-128, *in* Reports of explorations and surveys . . . from the Mississippi River to the Pacific Ocean . . . , 2.

Bee, J. W., and E. R. Hall
1956. Mammals of northern Alaska on the Arctic Slope. Misc. Publ., Univ. Kansas Mus. Nat. Hist., 8:1-309.

Beidleman, R. G.
1950. The cinereous shrew below 6000 feet in north central Colorado. Jour. Mamm., 31: 459.
1952. Possums and points west. Colorado Conservation, 1(4):2-5.
1953. The island of pines. Living Wilderness, 46:7-10.
1954. October breeding of *Peromyscus* in north central Colorado. Jour. Mamm., 35:118.
1955. An altitudinal record for the bison in northern Colorado. Jour. Mamm., 36:470-471.
1957. The hunting season of 1806. Colorado Outdoors, 6(2):26-30.

Beidleman, R. G., and J. D. Remington
1955. Another record of the least shrew from northeastern Colorado. Jour. Mamm., 36: 123.

Beidleman, R. G., and W. A. Weber
1958. Analysis of a pika hay pile. Jour. Mamm., 39:599-600.

Benson, S. B.
1934. Description of a race of the Mexican vole, *Microtus mexicanus*, from southeastern Utah. Proc. Biol. Soc. Washington, 47: 49-50.

1935a. The status of *Reithrodontomys montanus* (Baird). Jour. Mamm., 16:139-142.
1935b. A biological reconnaissance of Navajo Mountain, Utah. Univ. California Publ. Zool., 40:439-455.
1954. Records of the spotted bat *(Euderma maculata)* from California and Utah. Jour. Mamm., 35:117.

BERGTOLD, W. H.
1925. Unusual nesting of a raccoon. Jour. Mamm., 6:280-281.
1929. Bison in Colorado. Jour. Mamm., 10:170.

BIRNEY, E. C.
1970. Systematics of three species of woodrats (genus *Neotoma*) in central North America. Unpublished doctoral dissertation, University of Kansas, 277 pp.

BLACK, H. L.
1970. Occurrence of the Mexican big-eared bat in Utah. Jour. Mamm., 51:190.

BLACKWELDER, E.
1915. Post-Cretaceous history of the mountains of central and western Wyoming. Jour. Geol., 23:97-117, 193-267, 307-340.

BLAIR, W. F.
1938. A new race of the eastern cottontail from the Texas Panhandle. Occas. Papers, Mus. Zool. Univ. Michigan, 380:1-3.

BLAKE, I. H., AND A. K. BLAKE
1969. An ecological study of timberline and alpine areas, Mount Lincoln, Park County, Colorado. Univ. Nebraska Studies, 40 (n.s.):1-59.

BLISS, L. C.
1956. A comparison of plant development in microenvironments of Arctic and alpine tundra. Ecol. Monogr., 26:303-337.

BORCHERT, J. R.
1950. The climate of the central North American grassland. Ann. Assoc. Amer. Geogr., 40:1-39.

BORELL, A. E.
1961. Fox squirrel attacks mourning dove. Jour. Mamm., 42:101.

BRADLEY, W. G.
1967. Aberrant coloration in Clethrionomys gapperi from Colorado. Southwestern Nat., 12:198.

BRANSON, F. A., R. F. MILLER, AND I. S. MCQUEEN
1965. Plant communities and soil moisture relationships near Denver, Colorado. Ecology, 46:311-319.

BRAUN, C. E., AND R. G. STREETER
1968. Observations on the occurrence of white-tailed jackrabbits in the alpine zone. Jour. Mamm., 49:160-161.

BREWER, W. H.
1871. Animal life in the Rocky Mountains of Colorado. Amer. Nat., 5:220-223.

BROWN, J. H.
1968. Adaptation to environmental temperature in two species of woodrats, *Neotoma cinerea* and *N. albigula.* Misc. Publ., Mus. Zool. Univ. Michigan, 135:1-48.

BROWN, J. H., AND A. K. LEE
1969. Bergmann's rule and climatic adaptation in woodrats *(Neotoma).* Evolution, 23:329-338.

BROWN, J. H., AND C. F. WELSER
1968. Serum albumin polymorphism in natural and laboratory populations of *Peromyscus.* Jour. Mamm., 49:420-426.

BROWN, L. N.
1965. Abert's squirrel in southern Wyoming. Jour. Mamm., 46:516.
1966. First record of the pigmy shrew in Wyoming and description of a new subspecies (Mammalia: Insectivora). Proc. Biol. Soc. Washington, 79:49-51.
1967a. Seasonal activity patterns and breeding of the western jumping mouse (Zapus princeps) in Wyoming. Amer. Midland Nat., 78:460-470.
1967b. Ecological distribution of six species of shrews and comparison of sampling methods in the central Rocky Mountains. Jour. Mamm., 48:617-623.
1969. Reproductive characteristics of the Mexican woodrat at the northern limit of its range in Colorado. Jour. Mamm., 50:536-541.
1970. Population dynamics of the western jumping mouse *(Zapus princeps)* during a four-year study. Jour. Mamm., 51:651-658.

BROWN, L. P.
1923. Notes on a few mice, rabbits, and other animals. Jour. Mamm., 4:258-260.

BRYAN, K., AND L. L. RAY
1940. Geologic antiquity of the Lindenmeier Site in Colorado. Smithsonian Misc. Coll., 99 (3554):1-76.

BRYSON, R. A., D. A. BAERREIS, AND W. M. WENDLAND
1970. The character of late-glacial and postglacial climatic changes. Pp. 53-74, *in* Pleistocene and Recent environments of the Central Great Plains (W. Dort, Jr., and J. K. Jones, Jr., eds.), Spec. Publ. Dept. Geol., Univ. Kansas, 3:1-433.

BUCKMAN, H. O., AND N. C. BRADY
1960. The nature and properties of soils. The Macmillan Co., New York, 6th ed., 567 pp.

BUECHNER, H. K.
1960. The bighorn sheep in the United States—its past, present and future. Wildlife Monogr., 4:1-174.

BURNETT, W. L.
1913. Report on prairie dog investigations in Colorado. Circ. Colorado State Entomol., 8:3-13.
1915. The prairie dog situation in Colorado. Circ. Colorado State Entomol., 17:1-15.
1916a. Meadow mice (Microtus). Circ. Colorado Agric. College, 18:1-11.

1916b. The Wyoming ground squirrel in Colorado with suggestions for control. Circ. Colorado State Entomol., 20:1-11.
1920. A contribution to the life history of the Wyoming ground squirrel *(Citellus elegans)* in Colorado, Part 1. Circ. Colorado State Entomol., 30:1-12.
1923. Some Colorado farm pests with suggestions for their control. Circ. Colorado State Entomol., 35:1-24.
1924a. Distribution of the northern plains mole in Colorado. Jour. Mamm., 5:264.
1924b. The ground squirrels of Colorado. Circ. Colorado State Entomol., 44:1-19.
1925. Dichromatism and albinism in *Thomomys talpoides clusius.* Jour. Mamm., 6:129.
1930a. Preliminary notes on the action of strychnine on the Wyoming ground squirrel *(Citellus elegans elegans).* Press Bull., Colorado Agric. Exper. Sta., 72:1-3.
1930b. Hayden's vole, *Microtus haydeni* (Baird). Occas. Papers, Mus. Zool. and Entomol., Colorado Agric. College, 1:5-11.
1931. Life history studies of the Wyoming ground squirrel *(Citellus elegans elegans)* in Colorado. Bull. Colorado Agric. College, 373:1-23.

BURNETT, W. L., AND S. C. MCCAMPBELL
1926a. The Zuni prairie dog in Montezuma Co., Colorado. Circ. Colorado Agric. College, 49:1-15.
1926b. Jack rabbits of eastern Colorado. Circ. Colorado State Entomol., 52:1-18.

BURT, W. H.
1933. Additional notes on the mammals of southern Arizona. Jour. Mamm., 14:114-122.

CAHALANE, V. H.
1948. The status of mammals in the U.S. National Park system. Jour. Mamm., 29:247-259.
1954. Status of the black-footed ferret. Jour. Mamm., 35:418-424.

CAPP, J. C.
1968. Bighorn sheep, elk, mule deer range relationships.. Rocky Mt. Nat. Assoc., Estes Park, iii+75 pp.

CARLETON, W. M.
1966. Food habits of two sympatric Colorado sciurids. Jour. Mamm., 47:91-103.

CARY, M.
1907a. Some unrecorded Colorado mammals. Proc. Biol. Soc. Washington, 20:23-28.
1907b. A Colorado record of *Callospermophilus wortmani,* with notes on the recent capture of *Antrozous pallidus.* Proc. Biol. Soc. Washington, 20:85-86.
1911. A biological survey of Colorado. N. Amer. Fauna, 33:1-256.
1917. Life-zone investigations in Wyoming. N. Amer. Fauna, 42:1-95.

CATLETT, R. H., AND R. Z. BROWN
1961. Unusual abundance of *Peromyscus* at Gothic, Colorado. Jour. Mamm., 42:415.

CHURCHER, C. S.
1959. The specific status of the New World red fox. Jour. Mamm., 40:513-520.

CINQ-MARS, R. J., AND L. N. BROWN
1969. Reproduction and ecological distribution of the rockmouse, Peromyscus difficilis, in northern Colorado. Amer. Midland Nat., 81:205-217.

CLARK, T. W.
1968a. Food uses of the Richardson ground squirrel *(Spermophilus richardsoni elegans)* in the Laramie Basin in Wyoming. Southwestern Nat., 13:248-249.
1968b. Abiotic environmental factors affecting the daily and seasonal activity of the white-tailed prairie dog *(Cynomys leucurus).* Jour. Colorado-Wyoming Acad. Sci., 6(1): 60.
1970. Early growth, development, and behavior of the Richardson ground squirrel (Spermophilus richardsoni elegans). Amer. Midland Nat., 83:197-205.

CLARK, T. W., AND R. H. DENNISTON
1970. On the descriptive ethology of Richardson's ground squirrel. Southwestern Nat., 15: 193-200.

CLARK, T. W., R. S. HOFFMANN, AND C. F. NADLER
1971. Cynomys leucurus. Mammalian Species, 7: 1-4.

COCKERELL, T. D. A.
1890. Contributions toward a list of the fauna and flora of Wet Mountain Valley, IV. Mammalia. West Amer. Sci., 7:7-8.
1911. The fauna of Boulder County, Colorado. Univ. Colorado Studies, 8:227-256.
1915. Animals and plants described as new from Colorado in 1912, 1913, and 1914. Univ. Colorado Studies, 15:213-251.
1927. Zoology in Colorado. Univ. Colorado Semicentennial Ser., 3:7-262.

COCKERELL, T. D. A., L. I. MILLER, AND M. PRINTZ
1913. The relative lengths of the large and small intestines of rodents. Proc. Biol. Soc. Washington, 26:205-207.
1914. The auditory ossicles of American rodents. Bull. Amer. Mus. Nat. Hist., 33:347-380.

COCKERELL, T. D. A., AND R. W. L. POTTS
1943. Edward Royal Warren, 1860-1942. Jour. Mamm., 24:125-129.

COCKRUM, E. L.
1948. The distribution of the hispid cotton rat in Kansas. Trans. Kansas Acad. Sci., 51:306-312.
1951. A new pocket mouse (genus Perognathus) from Kansas. Univ. Kansas Publ., Mus. Nat. Hist., 5:203-206.
1952. Mammals of Kansas. Univ. Kansas Publ., Mus. Nat. Hist., 7:1-303.

1960. The Recent mammals of Arizona: their taxonomy and distribution. Univ. Arizona Press, Tucson, viii+276 pp.

COCKRUM, E. L., AND K. L. FITCH
1952. Geographic variation in red-backed mice (genus Clethrionomys) of the Southern Rocky Mountain Region. Univ. Kansas Publ., Mus. Nat. Hist., 5:281-292.

COLEMAN, A. D.
1965. Let's abolish the bounty. Colorado Outdoors, 14(1):1-3.

CONAWAY, C. H.
1952. Life history of the water shrew (Sorex palustris navigator). Amer. Midland Nat., 48:219-248.

CONLEY, W. H.
1970. Geographic variation in the least chipmunk, *Eutamias minimus*, in New Mexico and eastern Arizona. Jour. Mamm., 51:695-702.

CONSTANTINE, D. G.
1961a. Locality records and notes on western bats. Jour. Mamm., 42:404-405.
1961b. Spotted bat and big free-tailed bat in northern New Mexico. Southwestern Nat., 6:92-97.
1966. New bat locality records from Oaxaca, Arizona, and Colorado. Jour. Mamm., 47:125-126.

CORY, C. B.
1912. The mammals of Illinois and Wisconsin. Publ. Field Mus. Nat. Hist. (Zool. Ser.), 153:1-502.

COSTELLO, D. F.
1944a. Important species of the major forage types in Colorado and Wyoming. Ecol. Monogr., 14:107-134.
1944b. Natural revegetation of abandoned plowed land in the mixed prairie association of northeastern Colorado. Ecology, 25:313-326.
1954. Vegetation zones in Colorado. Pp. iii-x, *in* H. D. Harrington, Manual of the plants of Colorado, Sage Books, Denver, x+666 pp.

COTTAM, C.
1942. Coyote without external ears. Jour. Mamm., 23:450.

COUES, E.
1877. Fur-bearing mammals: a monograph of North American Mustelidae. . . . Misc. Publ., U.S. Geol. Surv. Territories, 8:xiv+348.
1879. Notice of Mrs. Maxwell's exhibit of Colorado mammals. Pp. 217-225, *in* M. A. Dartt-Thompson, On the plains and among the peaks; or, how Mrs. Maxwell made her natural history collection. Claxton, Remsen, and Haffelfinger, Philadelphia, 237 pp.

COUES, E., AND J. A. ALLEN
1877. Monographs of North American Rodentia. U.S. Geol. Surv. Territories, 11:x+1-1099.

COUES, E., AND H. C. YARROW
1875. Report on the collections of mammals made in portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona, during the years 1871, 1872, 1873, and 1874. . . . Explorations and surveys west of the one hundredth meridian. . . . Wheeler, 5:35-129, 969-976.

COWAN, I. McT.
1940. Distribution and variation in the native sheep of North America. Amer. Midland Nat., 24:505-580.

CRUZAN, J.
1968. Ecological distributions and interactions of four species of *Microtus* in Colorado. Unpublished doctoral dissertation, University of Colorado, 129 pp.

CULBREATH, J. C.
1947. Colorado's exchange of game. Colorado Conservation Comments, 10(4):3-4.

DALQUEST, W. W.
1943. The systematic status of the races of the little big-eared bat *Myotis evotis* H. Allen. Proc. Biol. Soc. Washington, 56:1-2.
1946. A new name for the desert race of the bat, Myotis californicus. Proc. Biol. Soc. Washington, 59:67-68.
1948. Mammals of Washington. Univ. Kansas Publ., Mus. Nat. Hist., 2:1-444.

DARLINGTON, P. J., JR.
1957. Zoogeography: the geographical distribution of animals. John Wiley and Sons, New York, xi+675 pp.

DAUBENMIRE, R. F.
1938. Merriam's life zones of North America. Quart. Rev. Biol., 13:327-332.
1943. Vegetational zonation in the Rocky Mountains. Botan. Rev., 9:325-393.
1954. Alpine timberlines in the Americas and their interpretation. Butler Univ. Botan. Studies, 11:119-136.

DAVIS, W. B.
1934. A study of the Idaho jumping mice of the genus Zapus, with remarks on a few specimens from British Columbia. Jour. Mamm., 15:221-227.

DAVIS, W. H.
1968. [Report on bat studies in Colorado and New Mexico]. Bat Research News, 9:49-50.

DEEVEY, E. S., JR.
1958. Recent advances in Pleistocene stratigraphy and biogeography. Pp. 594-623, *in* Vertebrate speciation (W. F. Blair, ed.), Univ. Texas Press, Austin, xvi+642 pp.
1965. Pleistocene nonmarine environments. Pp. 643-652, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

DEEVEY, E. S., JR., AND R. F. FLINT
1957. Postglacial Hypsithermal Interval. Science, 125:182-184.

Dexter, R. W.
1957. The yellow-haired porcupine as a highway casualty. Jour. Mamm., 38:526.

Dice, L. R.
1923. Life zones and mammalian distribution. Jour. Mamm., 4:39-47.
1927. The Colorado pika in captivity. Jour. Mamm., 8:228-231.
1929. An attempt to breed cottontail rabbits in captivity. Jour. Mamm., 10:225-229.
1933. Variation in *Peromyscus maniculatus rufinus* from Colorado and New Mexico. Occas. Papers, Mus. Zool. Univ. Michigan, 271:1-32.
1935a. Inheritance of waltzing and epilepsy in mice of the genus Peromyscus. Jour. Mamm., 16:25-35.
1935b. A study of racial hybrids in the deermouse, *Peromyscus maniculatus*. Occas. Papers, Mus. Zool. Univ. Michigan, 312: 1-22.
1943. The biotic provinces of North America. Univ. Michigan Press, Ann Arbor, viii+ 78 pp.
1952. Natural communities. Univ. Michigan Press, Ann Arbor, x+547 pp.

Dillon, L. S.
1956. Wisconsin climate and life zones in North America. Science, 123:167-176.

Dixon, J. S.
1931. Pika versus weasel. Jour. Mamm., 12:72.

Dorf, E.
1960. Climatic changes of the past and present. Amer. Sci., 48:341-364.

Dorrance, M. J.
1966. A literature review on behavior of mule deer. Spec. Rept., Colorado Game, Fish and Parks Dept., 7:1-26.

Dorst, J.
1953. [Review of] Guide to the mammals of Colorado. Mammalia, 17:127.

Douglas, C. L.
1963. Apache pocket mouse found in Mesa Verde National Park, Colorado. Southwestern Nat., 8:173.
1967. New records of mammals from Mesa Verde National Park, Colorado. Jour. Mamm., 48:322-323.
1969a. Ecology of pocket gophers of Mesa Verde, Colorado. Pp. 147-175, *in* Contributions in mammalogy (J. K. Jones, Jr., ed.), Misc. Publ., Univ. Kansas Mus. Nat. Hist., 51: 1-428.
1969b. Comparative ecology of pinyon mice and deer mice in Mesa Verde National Park, Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 18:421-504.

Douglas, L. H.
1938. The principal factors controlling big game populations in the central Rocky Mountain Region. Trans. 3rd North Amer. Wildlife Conf., 296-301.

Doutt, J. K.
1941. New *Clethrionomys* from Utah and Pennsylvania. Proc. Biol. Soc. Washington, 54: 161-164.

Downhower, J. F., and J. D. Pauley
1970. Automated recordings of body temperature from free-ranging yellow-bellied marmots. Jour. Wildl. Mgt., 34:639-641.

Duellman, W. E.
1965. A biogeographic account of the herpetofauna of Michoacán, México. Univ. Kansas Publ., Mus. Nat. Hist., 15:627-709.

Durrant, S. D.
1952. Mammals of Utah, taxonomy and distribution. Univ. Kansas Publ., Mus. Nat. Hist., 6:1-549.
1955. In defense of the subspecies. Syst. Zool., 4:186-190.

Durrant, S. D., and H. S. Crane
1948. Three new beavers from Utah. Univ. Kansas Publ., Mus. Nat. Hist., 1:407-417.

Durrant, S. D., and N. K. Dean
1959. Mammals of Glen Canyon. Anthro. Papers, Univ. Utah, 40:73-106.
1960. Mammals of Flaming Gorge Reservoir Basin. Anthro. Papers, Univ. Utah, 48:209-235.
1961. Mammals of the Navajo Reservoir Basin in Colorado and New Mexico, 1960. Anthro. Papers, Univ. Utah, 55:155-182.

Durrant, S. D., and R. M. Hansen
1954. Distribution patterns and phylogeny of some western ground squirrels. Syst. Zool., 3:82-85.
1955. Taxonomic status of ground squirrels, *Citellus lateralis* (Say), from northeastern Utah and northwestern Colorado. Jour. Mamm., 36:136-138.

Durrant, S. D., and E. B. Robinson
1962. Mammals of the Gunnison River Basin. Anthro. Papers, Univ. Utah, 59:233-263.

Duszynski, D. W., and A. B. Howkins
1968. *Isospora peromysci* Davis, 1967, in *Peromyscus maniculatus* in northeastern Colorado. Jour. Parasit., 54:640.

Duszynski, D. W., and W. C. Marquardt
1969. *Eimeria* (Protozoa: Eimeriidae) in the cottontail rabbit *Sylvilagus audubonii* in northeastern Colorado, with descriptions of three new species. Jour. Protozool., 16: 128-137.

Dyer, W. G.
1969. A checklist of the Protozoa and helminths of the deer mouse, *Peromyscus maniculatus*, in North America. Amer. Midland Nat., 81:258-262.

Dyer, W. G., and O. W. Olsen
1967. Helminths of the deer mouse *(Peromyscus maniculatus)* from northern Colorado. Bull. Wildlife Disease Assoc., 3:35-36.

Ecke, D. H., and C. W. Johnson
1950. Sylvatic plague in Park County, Colorado. Trans. 15th North Amer. Wildlife Conf., 191-197.

Egoscue, H. J.
1964. The kit fox in southwestern Colorado. Southwestern Nat., 9:40.

Elliot, D. G.
1907. A catalog of the collection of mammals in the Field Columbian Museum. Publ. Field Columbian Mus. (Zool. Ser.), 115:viii+1-694.

Ellison, L.
1946. The pocket gopher in relation to soil erosion on mountain range. Ecology, 27:101-114.

Emerson, F. W.
1932. Tension zone between grama grass and piñon-juniper associations in northeastern New Mexico. Ecology, 13:347-358.

Engel, R. L., and T. A. Vaughan
1966. A coyote-eagle association. Jour. Mamm., 47:143.

Engels, W. L.
1936. Distribution of races of the brown bat (Eptesicus) in western North America. Amer. Midland Nat., 17:653-660.

Engle, E. T.
1924. Breeding record of a beaver. Jour. Mamm., 5:202.

Erdman, J. A., C. L. Douglas, and J. W. Marr
1969. Environment of Mesa Verde, Colorado (Wetherill Mesa Studies). Research Ser., National Park Service, 7B:1-72.

Erpino, M. J.
1968. Copulatory behavior in the white-tailed prairie dog. Amer. Midland Nat., 79:250-251.

Esch, G. W., R. G. Beidleman, and L. E. Long
1959. Early breeding of the black-tailed jack rabbit in southeastern Colorado. Jour. Mamm., 40:442-443.

Farney, J. P., and E. D. Fleharty
1969. Aspect ratio, loading, wing span, and membrane areas of bats. Jour. Mamm., 50:362-367.

Farnham, T. J.
1839. Travels in the great western prairies, the Anahuac and Rocky Mountains, and the Oregon Territory. Richard Bentley, London, 2 vols.

Faust, R. A., and T. J. Nimlos
1968. Soil microorganisms and soil nitrogen of the Montana alpine. Northwest Sci., 42:101-107.

Felger, A. H.
1910. Notes on birds and mammals of northwestern Colorado. Univ. Colorado Studies, 7:132-146.

Feltner, G.
1962. A look back—a 65-year history of the Colorado Game and Fish Department. Pp. 4-49, *in* Annual Report, Colorado Game and Fish Department, for 1961, 65 pp.

Fenneman, N. M.
1931. Physiography of western United States. McGraw-Hill Book Co., New York, xiii+534 pp.

Figgins, J. D.
1915. Diagnosis of a new subspecies of marmot from Colorado. Proc. Biol. Soc. Washington, 28:147-148.
1933. The bison of the western area of the Mississippi Basin. Proc. Colorado Mus. Nat. Hist., 12:16-33.

Findley, J. S.
1954a. Competition as a possible limiting factor in the distribution of *Microtus*. Ecology, 35:418-420.
1954b. Reproduction in two species of *Myotis* in Jackson Hole, Wyoming. Jour. Mamm., 35:434.
1955. Speciation of the wandering shrew. Univ. Kansas Publ., Mus. Nat. Hist., 9:1-68.
1961. Geographic variation in New Mexican chickarees. Jour. Mamm., 42:313-322.
1969. Biogeography of southwestern boreal and desert mammals. Pp. 113-128, *in* Contributions in mammalogy (J. K. Jones, Jr., ed.), Misc. Publ., Univ. Kansas Mus. Nat. Hist., 51:1-428.

Findley, J. S., and S. Anderson
1956. Zoogeography of montane mammals of Colorado. Jour. Mamm., 37:80-82.

Findley, J. S., and C. J. Jones
1962. Distribution and variation of voles of the genus *Microtus* in New Mexico and adjacent areas. Jour. Mamm., 43:154-166.
1967. Taxonomic relationships of bats of the species *Myotis fortidens, M. lucifugus,* and *M. occultus.* Jour. Mamm., 48:429-444.

Findley, J. S., and N. C. Negus
1953. Notes on the mammals of the Gothic region, Gunnison County, Colorado. Jour. Mamm., 34:235-239.

Findley, J. S., and G. L. Traut
1970. Geographic variation in *Pipistrellus hesperus.* Jour. Mamm., 51:741-765.

Finley, R. B., Jr.
1954. *Notiosorex crawfordi* and *Antrozous pallidus* from southeastern Colorado. Jour. Mamm., 35:110-111.
1958. The wood rats of Colorado: distribution and ecology. Univ. Kansas Publ., Mus. Nat. Hist., 10:213-552.
1959. Observation of nocturnal animals by red light. Jour. Mamm., 40:591-594.
1969. Cone caches and middens of Tamiasciurus in the Rocky Mountain Region. Pp. 233-273, *in* Contributions in mammalogy (J. K. Jones, Jr., ed.), Misc. Publ., Univ. Kansas Mus. Nat. Hist., 51:1-428.

Finney, B. A.
1962. Reexamination of small mammal populations in Moon Gulch, Gilpin County, Colorado. Jour. Colorado-Wyoming Acad. Sci., 5(3):42.

Fitzgerald, J. P.
1969. Sylvatic plague in Gunnison's prairie dog *(Cynomys gunnisoni)* and associated mammals in South Park, Colorado. Jour. Colorado-Wyoming Acad. Sci., 7(1):45.

Fleharty, E. D., and D. L. Stadel
1968. Distribution of Peromyscus leucopus (woods mouse) in western Kansas. Trans. Kansas Acad. Sci., 7:231-233.

Forbes, R. B.
1964. Some aspects of the life history of the silky pocket mouse, Perognathus flavus. Amer. Midland Nat., 72:439-444.

Fryxell, F. M.
1926. A new high altitude limit for the American bison. Jour. Mamm., 7:102-109.
1928. The former range of the bison in the Rocky Mountains. Jour. Mamm., 9:129-139.

Gebhard, P. H.
1949. An archeological survey of the blowouts of Yuma County, Colorado. Amer. Antiquity, 15:132-143.

Geiger, R.
1965. The climate near the ground. Harvard Univ. Press, Cambridge, xiv+611 pp.

Gennaro, A. L.
1968. Northern geographic limits of four desert rodents of the genera Peromyscus, Perognathus, Dipodomys, and Onychomys in the Rio Grande Valley. Amer. Midland Nat., 80:477-493.

Gerber, J. D., and E. C. Birney
1968. Immunological comparisons of four subgenera of ground squirrels. Syst. Zool., 17: 413-416.

Gilbert, P. F., and D. L. Gilbert
1970. A melanistic chipmunk from Colorado. Southwestern Nat., 15:264-265.

Gilbert, P. F., and R. R. Hill
1955. Healing of the fractured leg bone of an elk. Jour. Mamm., 37:129.
1960. A badger-skunk encounter. Jour. Mamm., 41:139.

Gillis, J. E.
1968. The activity of the big brown bat. Unpublished master's thesis, Colorado State University, 30 pp.

Gittings, E. B.
1941. Climate of Colorado. Pp. 798-808, *in* Climate and man, the yearbook of agriculture. U.S.D.A., Washington, 1248 pp.

Glass, B. P.
1947. Geographic variation in Perognathus hispidus. Jour. Mamm., 28:174-179.
1971. The type locality of *Dipodomys ordii richardsoni.* Southwestern Nat., 15:497-499.

Glass, B. P., and R. J. Baker
1965. *Vespertilio subulatus* Say, 1823: proposed suppression. Bull. Zool. Nomen., 22:204-205.
1968. The status of the name *Myotis subulatus* Say. Proc. Biol. Soc. Washington, 81:257-260.

Goin, O. B.
1944. A new race of the canyon mouse. Jour. Mamm., 25:189-191.

Goldman, E. A.
1910. Revision of the wood rats of the genus Neotoma. N. Amer. Fauna, 31:1-124.
1918. Five new mammals from Arizona and Colorado. Proc. Biol. Soc. Washington, 31:21-26.
1932a. A new cacomistle from Arizona. Proc. Biol. Soc. Washington, 45:87-88.
1932b. Two new rodents from Arizona. Proc. Biol. Soc. Washington, 45:89-91.
1936. New pocket gophers of the genus *Thomomys.* Jour. Washington Acad. Sci., 26:111-120.
1937. The Colorado River as a barrier in mammalian distribution. Jour. Mamm., 18:427-435.
1938a. Notes on the voles of the Microtus longicaudus group. Jour. Mamm., 19:491-492.
1938b. A new pocket mouse from Colorado. Jour. Mamm., 19:495-496.
1938c. List of the gray foxes of Mexico. Jour. Washington Acad. Sci., 28:494-498.
1944. Classification of wolves. Pp. 389-636, *in* S. P. Young and E. A. Goldman, The wolves of North America, Amer. Wildlife Inst., Washington, xvi+636 pp.
1946. Classification of the races of the puma. Pp. 175-302, *in* S. P. Young and E. A. Goldman, The puma, mysterious American cat. Amer. Wildlife Inst., Washington, xiv+358 pp.
1950. Raccoons of North and Middle America. N. Amer. Fauna, 60:vi+1-153.

Goldman, E. A., and M. C. Gardner
1947. Two new cotton rats. Jour. Mamm., 28: 57-59.

Gordon, K.
1931. A pregnant water shrew. Jour. Mamm., 12:429.
1936. Territorial behavior and social dominance among Sciuridae. Jour. Mamm., 17:171-172.
1938. Observations on the behavior of Callospermophilus and Eutamias. Jour. Mamm., 19:78-84.
1943. The natural history and behavior of the western chipmunk and the mantled ground squirrel. Studies in Zool., Oregon State Coll., 5:1-104.

Gough, B. J., and S. S. Kilgore
1964. A comparative hematological study of *Peromyscus* in Louisiana and Colorado. Jour. Mamm., 45:421-428.

Grange, W. B.
1928. A beaver's fearlessness. Jour. Mamm., 9: 66-67.

Gregg, R. E.
1963. The ants of Colorado. Univ. Colorado Press, Boulder, xvi+792 pp.

Grinnell, G. B.
1926. Some habits of the wolverine. Jour. Mamm., 7:30-34.
1929. Pronghorn antelope. Jour. Mamm., 10: 135-141.

Grinnell, J., J. S. Dixon, and J. M. Linsdale
1937. Fur-bearing mammals of California. Univ. California Press, Berkeley, 2 vols.

Gruchy, D. F.
1950. Status of the opossum, Didelphis virginiana, in Colorado. Jour. Colorado-Wyoming Acad. Sci., 4(2):76.

Guilday, J. E., H. W. Hamilton, and E. K. Adam
1967. Animal remains from Horned Owl Cave, Albany County, Wyoming. Contrib. Geol., Univ. Wyoming, 6:97-99.

Hagmeier, E. M.
1956. Distribution of marten and fisher in North America. Canadian Field-Nat., 70:149-168.
1961. Variation and relationships in North American marten. Canadian Field-Nat., 75:122-138.
1966. A numerical analysis of the distributional patterns of North American mammals, II. Re-evaluation of the provinces. Syst. Zool., 15:279-299.

Hagmeier, E. M., and C. D. Stults
1964. A numerical analysis of the distribution patterns of North American mammals. Syst. Zool., 13:125-155.

Hahn, D. E.
1966. The nine-banded armadillo, *Dasypus novemcinctus,* in Colorado. Southwestern Nat., 11:303.

Hall, E. R.
1931. Critical comments on mammals from Utah, with descriptions of new forms from Utah, Nevada, and Washington. Univ. California Publ. Zool., 37:1-13.
1936. Mustelid mammals from the Pleistocene of North America with systematic notes on some Recent members of the genera Mustela, Taxidea and Mephitis. Publ. Carnegie Inst. Washington, 473:41-119.
1938. Notes on the meadow mice Microtus montanus and M. manus with description of a new subspecies from Colorado. Proc. Biol. Soc. Washington, 51:131-134.
1945. A revised classification of the American ermines with description of a new subspecies from the western Great Lakes Region. Jour. Mamm., 26:175-182.
1946. Mammals of Nevada. Univ. California Press, Berkeley, xi+710 pp.
1951a. A new pocket gopher (genus *Thomomys*) from eastern Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 5:81-85.
1951b. American weasels. Univ. Kansas Publ., Mus. Nat. Hist., 4:1-466.
1955. Handbook of mammals of Kansas. Misc. Publ., Univ. Kansas Mus. Nat. Hist., 7:1-303.

Hall, E. R., and W. W. Dalquest
1950. A synopsis of American bats of the genus *Pipistrellus.* Univ. Kansas Publ., Mus. Nat. Hist., 1:591-602.

Hall, E. R., and D. F. Hoffmeister
1942. Geographic variation in the canyon mouse, *Peromyscus crinitus.* Jour. Mamm., 23:51-65.

Hall, E. R., and K. R. Kelson
1952. Comments on the taxonomy and geographic distribution of some North American rodents. Univ. Kansas Publ., Mus. Nat. Hist., 5:343-371.
1959. The mammals of North America. Ronald Press, New York, 2 vols.

Hall, E. R., and H. G. Montague
1951. Two new pocket gophers from Wyoming and Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 5:25-32.

Halvorsen, C. H.
1961. Curiosity of a marten. Jour. Mamm., 42: 111-112.

Handley, C. O., Jr.
1959. A revision of the American bats of the genera *Euderma* and *Plecotus.* Proc. U.S. Nat. Mus., 110:95-246.

Hansen, R. M.
1960a. Pocket gophers in Colorado. Bull. Colorado State Univ. Exper. Sta., 508-S:1-26.
1960b. Age and reproductive characteristics of mountain pocket gophers in Colorado. Jour. Mamm., 41:323-335.
1962a. Movements and survival of *Thomomys talpoides* in a mima-mound habitat. Ecology, 43:151-154.
1962b. Dispersal of Richardson ground squirrel in Colorado. Amer. Midland Nat., 68:58-66.
1963. Cotton rat from Kiowa County, Colorado. Jour. Mamm., 44:126.
1965. Pocket gopher density in an enclosure of native habitat. Jour. Mamm., 46:508-509.
1967. Pocket gopher digging behavior in rocky soils. Progress Rept., Colorado Agric. Exper. Sta., 232:1-2.

Hansen, R. M., and G. D. Bear
1963. Winter coats of white tailed jackrabbits in southwestern Colorado. Jour. Mamm., 44: 420-421.
1964. Comparison of pocket gophers from alpine, subalpine, and shrub-grassland habitats. Jour. Mamm., 45:638-640.

Hansen, R. M., and R. F. Beck
1968. Habitat of pocket gophers in Cochetopa Creek drainage, Colorado. Amer. Midland Nat., 79:103-117.

Hansen, R. M., and J. T. Flinders
1969. Food habits of North American hares. Sci. Series, Dept. Range Science, Colorado State Univ., 1:ii+1-18.

Hansen, R. M., and R. S. Miller
1959. Observations on the plural occupancy of pocket gopher burrow systems. Jour. Mamm., 40:577-584.

Hansen, R. M., and M. J. Morris
1968. Movement of rocks by northern pocket gophers. Jour. Mamm., 49:391-399.

Hansen, R. M., and L. D. Reed
1969. Energy assimilation in Richardson ground squirrels. Amer. Midland Nat., 82:290-292.

Hansen, R. M., and E. E. Remmenga
1961. Nearest neighbor concept applied to pocket gopher populations. Ecology, 42:812-814.

Hansen, R. M., and A. L. Ward
1966. Some relations of pocket gophers to rangelands on Grand Mesa, Colorado. Tech. Bull., Colorado Agric. Exper. Sta., 88:1-22.

Harrington, F. A., Jr.
1959. Further incidence of white-tailed deer in Colorado. Jour. Mamm., 40:251-252.

Harris, A. H.
1963. Ecological distribution of some vertebrates in the San Juan Basin, New Mexico. Papers in Anthro., Museum of New Mexico Press, 8:1-63.

Harris, A. H., and J. S. Findley
1962. Status of *Myotis lucifugus phasma* and comments on variation in *Myotis yumanensis.* Jour. Mamm., 43:192-199.

Hatfield, D. M.
1936. A revision of the Pipistrellus hesperus group of bats. Jour. Mamm., 17:257-262.

Hatt, R. T.
1927. Notes on the ground-squirrel, Callospermophilus. Occas. Papers, Mus. Zool. Univ. Michigan, 185:1-22.
1943. The pine squirrel in Colorado. Jour. Mamm., 24:311-345.

Hay, K. G.
1957. Record beaver litter for Colorado. Jour. Mamm., 38:268-269.

Hay, K. G., G. N. Hunter, and L. Robbins
1961. Big game management in Colorado, 1949-1958. Tech. Bull., Colorado Dept. of Game and Fish, 8:1-112.

Hayden, F. V.
1863. On the geology and natural history of the Upper Missouri. Trans. Amer. Phil. Soc., 12 (n.s.):1-218.
1878. Tenth annual report of the United States Geological and Geographical Survey of the territories. Government Printing Office, Washington, xxix+546 pp.

Hayward, C. L.
1949. The short-tailed weasel in Utah and Colorado. Jour. Mamm., 30:436-437.
1952. Alpine biotic communities of the Uinta Mountains, Utah. Ecol. Monogr., 22:92-118.

Hayward, C. L., and M. L. Killpack
1956. Occurrence of *Perognathus fasciatus* in Utah. Jour. Mamm., 37:451.

Henderson, F. R., P. F. Springer, and R. Adrian
1969. The black-footed ferret in South Dakota. South Dakota Dept. of Game, Fish and Parks, 19 unnumbered pages.

Henderson, J., and T. D. A. Cockerell
1913. Notes on the pikas of Colorado. Proc. Biol. Soc. Washington, 26:125-128.

Herin, R. A.
1968. Physiological studies in the Rocky Mountain elk. Jour. Mamm., 49:762-764.

Hershkovitz, P.
1957. The type locality of *Bison bison* Linnaeus. Proc. Biol. Soc. Washington, 70:31-32.

Hibbard, C. W.
1949. Pleistocene stratigraphy and paleontology of Meade County, Kansas. Paleo. Contrib., Univ. Michigan Mus., 7:63-90.
1958. Summary of North American Pleistocene mammalian local faunas. Papers Michigan Acad. Sci., Arts, and Letters, 43:3-32.

Hibbard, C. W., D. E. Ray, D. E. Savage, D. W. Taylor, and J. E. Guilday
1965. Quaternary mammals of North America. Pp. 509-525, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. E. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

Hibbard, C. W., and D. W. Taylor
1960. Two late Pleistocene faunas from southwestern Kansas. Paleo. Contrib., Univ. Michigan Museum, 16:1-233.

Hibbs, L. D.
1966. A literature review on mountain goat ecology. Spec. Rept., Colorado Game, Fish and Parks Dept., 8:1-23.
1967. Food habits of the mountain goat in Colorado. Jour. Mamm., 48:242-248.

Hibbs, L. D., F. A. Glover, and D. L. Gilbert
1969. The mountain goat in Colorado. Trans. 34th North Amer. Wildlife Conf., 409-418.

Hill, J. E.
1942. Notes on mammals of northeastern New Mexico. Jour. Mamm., 23:75-82.

Hill, J. E., and C. W. Hibbbard
1943. Ecological differentiation between two harvest mice *(Reithrodontomys)* in western Kansas. Jour. Mamm., 24:22-25.

Hjelte, C.
1956. Opossum. Colorado Outdoors, 5(4):8-10.

Hoeman, J. V.
1964. High altitude winter records for white-tailed jackrabbits. Jour. Mamm., 45:495.

Hoffmann, R. S., and J. K. Jones, Jr.
1970. Influence of late-glacial and post-glacial events on the distribution of Recent mammals on the Northern Great Plains. Pp. 355-394, *in* Pleistocene and Recent environments of the central Great Plains (W. Dort, Jr., and J. K. Jones, Jr., eds.), Spec. Publ. Dept. Geol., Univ. Kansas, 3:1-433.

HOFFMANN, R. S., AND C. F. NADLER
1968. Chromosomes and systematics of some North American species of the genus *Marmota* (Rodentia: Sciuridae). Experientia, 24:740-742.

HOFFMANN, R. S., AND R. D. TABER
1967. Origin and history of Holarctic tundra ecosystems, with special reference to their vertebrate faunas. Pp. 143-170, *in* Arctic and alpine environments (H. E. Wright, Jr., and W. H. Osborn, eds.), Indiana Univ. Press, Bloomington, xii+308 pp.

HOFFMANN, R. S., P. L. WRIGHT, AND F. E. NEWBY
1969. The distribution of some mammals in Montana, I. Mammals other than bats. Jour. Mamm., 50:579-604.

HOFFMEISTER, D. F.
1951. A taxonomic and evolutionary study of the piñon mouse, *Peromyscus truei.* Illinois Biol. Monogr., 21:x+1-104.
1956. A record of *Sorex merriami* from northeastern Colorado. Jour. Mamm., 37:276.
1964. Mammals and life zones: time for reevaluation. Plateau, 37:46-55.
1967. An unusual concentration of shrews. Jour. Mamm., 48:462-464.
1969. The species problem in the Thomomys bottae-Thomomys umbrinus complex of pocket gophers in Arizona. Pp. 75-91, *in* Contributions in mammalogy (J. K. Jones, Jr., ed.), Misc. Publ., Univ. Kansas Mus. Nat. Hist., 51:1-428.

HOFFMEISTER, D. F., AND L. DE LA TORRE
1961. Geographic variation in the mouse *Peromyscus difficilis.* Jour. Mamm., 42:1-13.

HOFFMEISTER, D. F., AND M. R. LEE
1963. Revision of the desert cottontail, *Sylvilagus audubonii,* in the Southwest. Jour. Mamm., 44:501-518.

HOGUE, J.
1958. The red fox. Colorado Outdoors, 7(1):12-14.

HOLLISTER, N.
1911. A systematic synopsis of the muskrats. N. Amer. Fauna, 32:1-47.
1912. Mammals of the Alpine Club Expedition to the Mount Robson Region. Canadian Alpine Jour., Spec. Number, 44 pp.
1914. A systematic account of the grasshopper mice. Proc. U.S. Nat. Mus., 17:427-489.
1916. A systematic account of the prairie dogs. N. Amer. Fauna, 40:1-37.

HOOPER, E. T.
1940. A new race of pocket gopher of the species Geomys lutescens from Colorado. Occas. Papers, Mus. Zool. Univ. Michigan, 420:1-3.
1944. The name Neotoma cinerea cinnamomea applied to woodrats from southwestern Wyoming. Jour. Mamm., 25:415.
1952. A systematic review of the harvest mice (genus *Reithrodontomys*) of Latin America. Misc. Publ., Mus. Zool. Univ. Michigan, 77:1-255.

HOOPER, E. T., AND B. S. HART
1962. A synopsis of Recent North American microtine rodents. Misc. Publ., Mus. Zool. Univ. Michigan, 120:1-68.

HOOVER, R. L.
1954. Seven fetuses in western fox squirrel *(Sciurus niger rufiventer).* Jour. Mamm., 35:447-448.

HOOVER, R. L., C. E. TILL, AND S. OGILVIE
1959. The antelope of Colorado. Tech. Bull., Colorado Dept. of Game and Fish, 4:1-110.

HOOVER, R. L., AND L. E. YEAGER
1953. Status of the fox squirrel in northeastern Colorado. Jour. Mamm., 34:359-365.

HOWARD, J. A.
1967. Variation in the big brown bat, *Eptesicus fuscus,* in Kansas. Unpublished master's thesis, University of Kansas, 37 pp.

HOWELL, A. B.
1926. Voles of the genus Phenacomys. N. Amer. Fauna, 48:1-66.

HOWELL, A. H.
1901. Revision of the skunks of the genus Chincha. N. Amer. Fauna, 20:1-62.
1914. Revision of the American harvest mice (genus Reithrodontomys). N. Amer. Fauna, 36:1-97.
1915. Revision of the American marmots. N. Amer. Fauna, 37:1-80.
1922. Diagnoses of seven new chipmunks of the genus Eutamias, with a list of the American species. Jour. Mamm., 3:178-185.
1924. Revision of the American pikas (genus Ochotona). N. Amer. Fauna, 47:1-57.
1929. Revision of the American chipmunks (genera *Tamias* and *Eutamias*). N. Amer. Fauna, 52:1-157.
1935. The harvest mice of the San Luis Valley, Colorado. Jour. Mamm., 16:143-144.
1938. Revision of the North American ground squirrels, with a classification of the North America Sciuridae. N. Amer. Fauna, 56:1-256.

HUHEEY, J. E.
1965. A mathematical method of analyzing biogeographical data, I. Herpetofauna of Illinois. Amer. Midland Nat., 73:490-500.

HUNT, C. B.
1953. Pleistocene-Recent boundary in the Rocky Mountain Region. Bull. U.S. Geol. Surv., 996-A:1-25.
1954. Pleistocene and Recent deposits in the Denver area, Colorado. Bull. U.S. Geol. Surv., 996-C:91-140.
1956. Cenozoic geology of the Colorado Plateau. Prof. Paper, U.S. Geol. Surv., 279:iv+1-99.

HUNTER, G. N., AND R. G. KINGHORN
1950. Mountain sheep drive mule deer from food. Jour. Mamm., 31:193.

HUNTER, G. N., AND R. E. PILLMORE
1954. Hunting as a technique in studying lungworm infestations in bighorn sheep. Trans. 19th North Amer. Wildlife Conf., 117-129.

HUSSON, P. M.
1962. The bats of Suriname. E. J. Brill, Leiden, 282 pp.

IVES, R. L.
1950. Frequency and physical effects of chinook winds in the Colorado High Plains region. Ann. Assoc. Amer. Geogr., 40:293-327.

JACKSON, D., ED.
1966. The journals of Zebulon Montgomery Pike with letters and related documents. Univ. Oklahoma Press, Norman, 2 vols.

JACKSON, H. H. T.
1928. A taxonomic review of the American long-tailed shrews (genera *Sorex* and *Microsorex*). N. Amer. Fauna, 51:vi+1-238.
1951. Classification of the races of the coyote. Pp. 227-341, *in* S. P. Young and H. H. T. Jackson, The clever coyote. The Stackpole Co., Harrisburg, and Wildlife Mgt. Inst., Washington, xv+411 pp.

JAMES, E.
1823. Account of an expedition from Pittsburgh to the Rocky Mountains in the years 1819 and 20 . . . under the command of Major Stephen H. Long. Carey and Lea, Philadelphia, 2 vols.

JAMESON, D. L., J. P. MACKEY, AND R. C. RICHMOND
1966. The systematics of the Pacific tree frog, *Hyla regilla*. Proc. California Acad. Sci., 4th Ser., 33:551-620.

JOHNSON, D. R.
1967. Diet and reproduction of Colorado pikas. Jour. Mamm., 48:311-315.

JOHNSON, D. R., AND R. M. HANSEN
1969. Effects of range treatment with 2, 4-D on rodent populations. Jour. Wildlife Mgt., 33:125-132.

JOHNSON, D. R., AND M. H. MAXELL
1966. Energy dynamics of Colorado pikas. Ecology, 47:1059-1061.

JOHNSON, S. A.
1912. Prairie dogs and methods of control. Circ. Colorado State Entomol., 2:7-13.

JOHNSON, W. M.
1945. Natural revegetation of abandoned crop land in the ponderosa pine zone of the Pike's Peak region in Colorado. Ecology, 26:363-374.

JOHNSTONE, J. G., S. RAMARATHNUM, AND D. B. RICHARDS
1962. The soils of eastern Colorado—their origin, distribution and engineering characteristics. Quart. Colorado School of Mines, 57(3): 1-71.

JOLICOUER, P.
1959. Multivariate geographical variation in the wolf, *Canis lupus*. Evolution, 13:283-299.

JONES, J. K., JR.
1953. Geographic distribution of the pocket mouse, Perognathus fasciatus. Univ. Kansas Publ., Mus. Nat. Hist., 5:515-526.
1958a. A new bog lemming (genus Synaptomys) from Nebraska. Univ. Kansas Publ., Mus. Nat. Hist., 9:385-388.
1958b. The type locality and nomenclatorial status of Peromyscus maniculatus nebrascensis (Coues). Proc. Biol. Soc. Washington, 71: 107-112.
1960. The hispid cotton rat in Nebraska. Jour. Mamm., 41:132.
1964. Distribution and taxonomy of mammals of Nebraska. Univ. Kansas Publ., Mus. Nat. Hist., 16:1-356.

JONES, J. K., JR., AND J. S. FINDLEY
1954. Geographic distribution of the short-tailed shrew, Blarina brevicauda, in the Great Plains. Trans. Kansas Acad. Sci., 57:208-211.

JONES, J. K., JR., E. D. FLEHARTY, AND P. B. DUNNIGAN
1967. The distributional status of bats in Kansas. Misc. Publ., Univ. Kansas Mus. Nat. Hist., 46:1-33.

JONES, J. K., JR., AND H. H. GENOWAYS
1967. A new subspecies of the fringe-tailed bat, *Myotis thysanodes*, from the Black Hills of South Dakota and Wyoming. Jour. Mamm., 48:231-235.

JONES, J. K., JR., AND R. B. LOOMIS
1954. Records of the short-tailed shrew and least shrew in Colorado. Jour. Mamm., 35:110.

JONES, J. K., JR., AND B. MURSALOGLU
1961. Geographic variation in the harvest mouse, Reithrodontomys megalotis, on the central Great Plains and in adjacent regions. Univ. Kansas Publ., Mus. Nat. Hist., 14:9-27.

KALMBACH, E. R.
1953. Trout encounters porcupine. Jour. Mamm., 34:511.

KARTMAN, L., S. F. QUAN, AND R. R. LECHLEITNER
1962. Die-off of a Gunnison's prairie dog colony in central Colorado, II. Retrospective determination of plague infection in flea vectors, rodents and man. Zoonoses Res., 1: 201-224.

KEITH, J. O.
1965. The Abert squirrel and its dependence on ponderosa pine. Ecology, 46:150-163.

KEITH, J. O., R. M. HANSEN, AND A. L. WARD
1959. Effect of 2, 4-D on abundance of foods of pocket gophers. Jour. Wildlife Mgt., 23: 137-145.

KELSON, K. R.
1949. Two new woodrats from eastern Utah. Jour. Washington Acad. Sci., 39:417-419.
1951a. Speciation in rodents of the Colorado River drainage. Univ. Utah Biol. Ser., 11(3): vii+1-125.

1951b. Two new subspecies of *Thomomys bottae* from New Mexico and Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 5:59-71.

Kendeigh, S. C.
1954. History and evaluation of various concepts of plant and animal communities in North America. Ecology, 35:152-171.
1961. Animal ecology. Prentice-Hall, Englewood Cliffs, N.J., x+468 pp.

Kilgore, D. L., Jr.
1969. An ecological study of the swift fox (Vulpes velox) in the Oklahoma Panhandle. Amer. Midland Nat., 81:512-534.

King, P. B.
1959. The evolution of North America. Princeton Univ. Press, Princeton, 189 pp.

Kingman, R. G., and L. E. Yeager
1951. Plural canines in elk. Jour. Mamm., 32: 112-113.

Kinsella, J. M.
1968. *Monopsyllus thambus* (Jordan, 1929) from the alpine in Colorado. Jour. Parasit., 54: 258.

Knapp, R.
1965. Die Vegetation von Nord un Mittelamerica und der Hawaii Inseln. Gustav Fischer Verlag, Stuttgart, 2 vols.

Koford, C. B.
1958. Prairie dogs, whitefaces, and blue grama. Wildlife Monogr., 3:1-78.

Koplin, J. R., and R. S. Hoffmann
1968. Niche overlap and competitive exclusion in voles (Microtus). Amer. Midland Nat., 80: 494-507.

Kottlowski, F. E., M. E. Cooley, and R. V. Ruhe
1965. Quaternary geology of the Southwest. Pp. 287-298, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+ 922 pp.

Krear, H. R.
1965. An ecological and ethological study of the pika (*Ochotona princeps saxatilis* Bangs) in the Front Range of Colorado. Unpublished doctoral dissertation, University of Colorado, 352 pp.

Krutzsch, P. H.
1953. Supernumerary molars in the jumping mouse *(Zapus princeps)*. Jour. Mamm., 34: 265-266.
1954. North American jumping mice (genus Zapus). Univ. Kansas Publ., Mus. Nat. Hist., 7:349-472.

Küchler, A. W.
1964. The potential natural vegetation of the conterminous United States, 1:3,168,000. Spec. Publ., Amer. Geogr. Soc., 36:v+1-37.
1967. Vegetation mapping. Ronald Press Co., New York, 472 pp.
1968. Some geographic features of the Kansas prairie. Trans. Kansas Acad. Sci., 70:388-401.

Kurtén, B., and R. Rausch
1959. Biometric comparisons between North American and European mammals. Acta Arctica, 11:5-44.

Lange, K. I.
1959. Soricidae of Arizona. Amer. Midland Nat., 61:96-108.

Larson, F.
1940. The role of the bison in maintaining the short grass plains. Ecology, 21:113-121.

Lechleitner, R. R.
1958. An extra molar in *Erethizon*. Jour. Mamm., 39:447-448.
1964. Another record of the least shrew from Colorado. Jour. Mamm., 45:298.
1969. Wild mammals of Colorado: their appearance, habits, distribution, and abundance. Pruett Publishing Co., Boulder, xiv+254 pp.

Lechleitner, R. R., L. Kartman, M. I. Goldenburg, and B. W. Hudson
1968. An epizootic of plague in Gunnison's prairie dogs *(Cynomys gunnisoni)* in south-central Colorado. Ecology, 49:734-743.

Lechleitner, R. R., J. V. Tileston, and L. Kartman
1962. Die-off of a Gunnison's prairie dog colony in central Colorado, I. Ecological observations and description of the epizootic. Zoonoses Res., 1:185-199.

Lee, M. R.
1960. Montane mammals of southeastern Utah—with emphasis on the effects of past climates upon occurrence and differentiation. Unpublished doctoral dissertation, University of Utah, 204 pp.

Lee, M. R., and S. D. Durrant
1960. A new jumping mouse (*Zapus princeps* Allen) from Utah. Proc. Biol. Soc. Washington, 73:171-174.

Leopold, L. B.
1951. Late Pleistocene climate in New Mexico. Amer. Jour. Sci., 249:152-168.

Lewis, R. B.
1952. A faunistic study of mammal distribution in Colorado. Unpublished master's thesis, University of Colorado, 128 pp.

Lincoln, F. C.
1915. The birds of Yuma County, Colorado. Proc. Colorado Mus. Nat. Hist., 1(1):1-14.

Livingston, R. B.
1949. An ecological study of the Black Forest, Colorado. Ecol. Monogr., 19:123-144.
1952. Relict true prairie communities in central Colorado. Ecology, 33:72-86.

Lohman, S. W.
1961. Abandonment of Unaweep Canyon, Mesa County, Colorado, by capture of the Colorado and Gunnison rivers. Prof. Papers, U.S. Geol. Surv., 424-B:144-146.

Long, C. A.
1962. Records of reproduction for harvest mice. Jour. Mamm., 43:103-104.

1964. Meles montanus Richardson, 1829, and Meles jeffersonii Harlan, 1825: proposed suppression under the plenary powers (Mammalia, Carnivora). Bull. Zool. Nomen., 21:370-371.
1965. The mammals of Wyoming. Univ. Kansas Publ., Mus. Nat. Hist., 14:493-758.
1969. Gross morphology of the penis in seven species of the Mustelidae. Mammalia, 33: 145-160.
1971. Significance of the Late Pleistocene fauna from Little Box Elder Cave to studies of zoogeography of Recent mammals. Great Basin Nat., 31:93-105.

Long, C. A., and D. Cronkite
1970. Taxonomy and ecology of sibling chipmunks in central Colorado. Southwestern Nat., 14:283-291.

Long, C. A., and C. F. Long
1964. Geographic records of the swift fox, *Vulpes velox*. Southwestern Nat., 9:108.

Long, C. A., and R. G. Severson
1969. Geographical variation in the big brown bat in the north-central United States. Jour. Mamm., 50:621-624.

Long, W. S.
1938. The weasel as an enemy of the pika. Jour. Mamm., 19:150.

Longhurst, W. M.
1942. The summer food of burrowing owls in Costilla County, Colorado. Condor, 44: 281-282.
1944. Observations on the ecology of the Gunnison prairie dog in Colorado. Jour. Mamm., 25:24-36.

Loveless, C. M.
1967. Ecological characteristics of a mule deer winter range. Tech. Publ., Colorado Game, Fish and Parks Dept., 20:1-124.

Maher, L. J., Jr.
1961. Pollen analysis and post-glacial vegetational history in the Animas Valley region, southern San Juan Mountains, Colorado. Dissert. Abstr., 22(8):2755-2756.

Markham, H.
1907. Scientific expedition to northeastern Colorado, VI. List of mammals collected or noted. Univ. Colorado Studies, 4:145-165.

Marr, J. W.
1961. Ecosystems of the east slope of the Front Range in Colorado. Univ. Colorado Studies, Ser. in Biology, 8:1-134.

Martin, P. S.
1963. The last 10,000 years. Univ. Arizona Press, Tucson, 87 pp.

Maxell, M. H., and L. N. Brown
1968. Ecological distribution of rodents on the High Plains of eastern Wyoming. Southwestern Nat., 13:143-158.

Mayr, E.
1965. Animal species and evolution. Belknap Press of Harvard Univ. Press, Cambridge, vii+797 pp.
1969. Principles of systematic zoology. McGraw-Hill Book Co., New York, xi+428 pp.
1971. Methods and strategies in taxonomic research. Syst. Zool., 20:426-433.

McCampbell, S. C.
1926. A new ground squirrel for Colorado. Jour. Mamm., 7:60.

McCoy, C. J., Jr., and P. H. Miller
1964. Ecological distribution of the subspecies of *Ammospermophilus leucurus* in Colorado. Southwestern Nat., 9:89-93.

McCullough, D. R.
1969. The Tule elk, its history, behavior, and ecology. Univ. California Publ. Zool., 88: vii+1-209.

McKeever, S.
1964. The biology of the golden-mantled ground squirrel. Ecol. Monogr., 34:383-401.

McMillan, C.
1959. The role of ecotypic variation in the distribution of the central grassland of North America. Ecol. Monogr., 29:285-308.

Mead, R. A.
1968. Reproduction in western forms of the spotted skunk (genus *Spilogale*). Jour. Mamm., 49:373-390.

Merriam, C. H.
1890. Results of a biological survey of the San Francisco Mountain region and Desert of the Little Colorado in Arizona, I. General results . . . with special reference to the distribution of species. N. Amer. Fauna, 3:5-34.
1891. Mammals of Idaho. N. Amer. Fauna, 5: 31-87.
1893. Two new wood rats from the plateau region of Arizona. Proc. Biol. Soc. Washington, 8:109-112.
1894. Laws of temperature control of the geographic distribution of terrestrial animals and plants. Nat. Geogr. Mag., 6:229-238.
1901. Preliminary revision of the pumas (*Felis concolor* group). Proc. Washington Acad. Sci., 3:577-600.
1904. New and little known kangaroo rats of the genus *Perodipus*. Proc. Biol. Soc. Washington, 17:139-146.
1905. Two new chipmunks from Colorado and Arizona. Proc. Biol. Soc. Washington, 18: 163-166.
1918. Review of the grizzly and big brown bears of North America (genus *Ursus*) with description of a new genus, *Vetularctos*. N. Amer. Fauna, 41:1-36.
1929. Additional information on the range of Ursus planiceps, a Colorado grizzly. Proc. Biol. Soc. Washington, 42:171-172.

Milek, J. A., and H. Huizinga
1968. Karyotype analysis of two species in the genus *Neotoma*. Jour. Colorado-Wyoming Acad. Sci., 6(1):62-63.

Miller, A. H.
1951. An analysis of the distribution of the birds of California. Univ. California Publ. Zool., 50:531-644.

Miller, F. W.
1924a. Coues porcupine in Colorado. Jour. Mamm., 5:134.
1924b. The range of *Cryptotis parva* (Say). Jour. Mamm., 5:199.
1925. A new hog-nosed skunk. Jour. Mamm., 6: 50-51.
1928a. Identity of the northwest Colorado pocket mouse. Jour. Mamm., 9:337.
1928b. The range of *Reithrodontomys albescens albescens*. Jour. Mamm., 9:338.
1930a. A note on the pygmy vole in Colorado. Jour. Mamm., 11:83-84.
1930b. A note on the dusky shrew in captivity. Jour. Mamm., 11:311-312.
1930c. The spring moult of Mustela longicauda. Jour. Mamm., 11:471-473.
1930d. A new Colorado pocket gopher of the genus Thomomys. Proc. Colorado Mus. Nat. Hist., 9(3):41-43.
1931a. The fall moult of Mustela longicauda. Jour. Mamm., 12:150-152.
1931b. A feeding habit of the long-tailed weasel. Jour. Mamm., 12:164.
1931c. Notes on some Colorado wood rats. Jour. Mamm., 12:432.
1932. Colorado's mammals. Nature Mag., 19:297-299, 322-323.
1933a. Two new Colorado mammals. Proc. Colorado Mus. Nat. Hist., 12(1):1-2.
1933b. Concerning a recent record of Mustela rixosa in Colorado. Jour. Mamm., 14:368.
1939. The hand capture of conies. Jour. Mamm., 20:380.

Miller, F. W., and R. L. Landberg
1931. A sixth Colorado record of Phenacomys. Jour. Mamm., 12:165-166.

Miller, G. S., Jr.
1897. Revision of the North American bats of the family Vespertilionidae. N. Amer. Fauna, 13:1-140.
1930. The supposed occurrence of an Asiatic goat-antelope in the Pleistocene of Colorado. Smithsonian Misc. Coll., 82(3108): 1-2.

Miller, G. S., Jr., and G. M. Allen
1928. The American bats of the genera *Myotis* and *Pizonyx*. Bull. U.S. Nat. Mus., 144: viii+1-218.

Miller, G. S., Jr., and A. R. Kellogg
1955. List of North American Recent mammals. Bull. U.S. Nat. Mus., 205:xii+1-954.

Miller, J. C.
1942. Moose in Colorado. Colorado Conservation Comments, 5(1):12.

Miller, P. H.
1962. The Colorado National Monument bison herd. Jour. Colorado-Wyoming Acad. Sci., 5(3):44.
1964. The ecological distribution of mammals in Colorado National Monument, Mesa County, Colorado. Unpublished master's thesis, Oklahoma State University, 133 pp.

Miller, P. H., and C. J. McCoy, Jr.
1965. Kit fox in Colorado. Jour. Mamm., 46: 342-343.

Miller, R. S.
1958. Rate of incisor growth in the mountain pocket gopher. Jour. Mamm., 39:380-385.
1964. Ecology and distribution of pocket gophers (Geomyidae) in Colorado. Ecology, 45: 256-272.

Miller, R. S., and H. E. Bond
1960. Summer burrowing activity of pocket gophers. Jour. Mamm., 41:469-475.

Miller, R. S., and R. A. Ward
1960. Ectoparasites of pocket gophers from Colorado. Amer. Midland Nat., 64:382-391.

Mills, E. A.
1913. In beaver world. Houghton Mifflin Co., Boston, 228 pp.

Mohlenrich, J. S.
1961. Distribution and ecology of the hispid and least cotton rats in New Mexico. Jour. Mamm., 42:13-24.

Moir, W. H.
1969. The lodgepole pine zone in Colorado. Amer. Midland Nat., 81:87-98.

Morgan, M. D.
1969. Ecology of aspen in Gunnison County, Colorado. Amer. Midland Nat., 82:204-228.

Morse, R. C., and B. P. Glass
1960. The taxonomic status of *Antrozous bunkeri*. Jour. Mamm., 41:10-15.

Moser, C. A.
1962. The bighorn sheep of Colorado. Tech. Publ., Colorado Dept. Game and Fish, 10: 1-49.

Murie, O. J.
1951. The elk of North America. The Stackpole Co., Harrisburg, and Wildlife Mgt. Inst., Washington, 376 pp.

Murray, D. F.
1967. Gravel mounds at Rocky Flats, Colorado. Mtn. Geol., 4:99-107.

Myers, G. T., and T. A. Vaughan
1964. Food habits of the plains pocket gopher in eastern Colorado. Jour. Mamm., 45:588-598.

Nadler, C. F.
1964. Contributions of chromosomal analysis to the systematics of North American chipmunks. Amer. Midland Nat., 72:298-312.
1966. Chromosomes of *Spermophilus franklinii* and taxonomy of the ground squirrel genus *Spermophilus*. Syst. Zool., 15:199-206.
1968. The serum proteins and transferrins of the ground squirrel subgenus *Spermophilus*. Comp. Biochem. and Physiol., 27:487-503.

NADLER, C. F., AND M. H. BLOCK
1962. The chromosomes of some North American chipmunks (Sciuridae) belonging to the genera *Tamias* and *Eutamias*. Chromosoma, 13:1-15.
NADLER, C. F., AND K. E. HARRIS
1967. Chromosomes of the North American prairie dog *Cynomys ludovicianus*. Experientia, 23:41-42.
NADLER, C. F., AND C. E. HUGHES
1966. Chromosomes and taxonomy of the ground squirrel subgenus *Ictidomys*. Jour. Mamm., 47:46-53.
NEFF, D. J.
1957. Ecological effects of beaver habitat abandonment in the Colorado Rockies. Jour. Wildlife Mgt., 21:80-84.
1959. A seventy-year history of a Colorado beaver colony. Jour. Mamm., 40:381-387.
NELSON, E. W.
1909. The rabbits of North America. N. Amer. Fauna, 29:1-314.
1925. Status of the pronghorned antelope, 1922-1924. Bull. U.S. Dept. Agric., 1346:1-64.
NORRIS, T. M., AND B. H. BANTA
1965. The small mammal fauna sampled along a four-mile transect of prairie in El Paso County, Colorado, in 1963 and 1964. Jour. Colorado-Wyoming Acad. Sci., 5(6):54-55.
OGILVIE, S.
1955. Chokecherry toxic to antelope. Jour. Mamm., 36:146.
OLSEN, R. W.
1962. Mammals of the subaquatic habitats in the Blue Mesa Reservoir Basin, Colorado. Anthro. Papers, Univ. Utah, 59:222-232.
ORMES, R. M., ED.
1955. Guide to the Colorado mountains. Sage Books, Denver, 4th ed., 231 pp.
OSGOOD, W. H.
1907. Some unrecognized and misapplied names of American mammals. Proc. Biol. Soc. Washington, 20:43-52.
1909. Revision of the mice of the American genus Peromyscus. N. Amer. Fauna, 28:1-285.
1913. The name of the Rocky Mountain sheep. Proc. Biol. Soc. Washington, 26:57-62.
1914. Dates for Ovis canadensis, Ovis cervina, and Ovis montana. Proc. Biol. Soc. Washington, 27:1-4.
OUTCALT, S. I., AND D. D. MACPHAIL
1965. A survey of Neoglaciation in the Front Range of Colorado. Univ. Colorado Press, Boulder, 123 pp.
PACKARD, F. M.
1940. Beaver killed by coyotes. Jour. Mamm., 21:359-360.
1941. Measurements of a beaver at birth. Jour. Mamm., 22:89-90.
1946. An ecological study of the bighorn sheep in Rocky Mountain National Park, Colorado. Jour. Mamm., 27:3-28.
1947a. A study of deer and elk herds of Rocky Mountain National Park, Colorado. Jour. Mamm., 28:4-12.
1947b. A survey of the beaver population of Rocky Mountain National Park, Colorado. Jour. Mamm., 28:219-227.
PALMER, T. S.
1897. The jack rabbits of the United States. Bull. Biol. Surv., U.S.D.A., 8:1-84.
PAYNE, J. E.
1903. The prairie dog as range pest. Press Bull., Colorado Agric. Exper. Sta., 16:1-2.
PEATTIE, R.
1936. Mountain geography, a critique and field study. Harvard Univ. Press, Cambridge, xiv+257 pp.
PENNAK, R. W.
1963. Ecological and radiocarbon correlations in some Colorado mountain lake and bog deposits. Ecology, 44:1-15.
PETERSON, R. L.
1955. North American moose. Univ. Toronto Press, Toronto, xii+280 pp.
PETTUS, D., AND R. R. LECHLEITNER
1963. *Microsorex* in Colorado. Jour. Mamm., 44: 119.
POLUNIN, N. I.
1960. Introduction to plant geography. McGraw-Hill Book Co., New York, xix+640 pp.
POKROPUS, E. J., AND B. H. BANTA
1965. A report of the shrews sampled in the northern Wet Mountains: Custer and Fremont counties, Colorado. Jour. Colorado-Wyoming Acad. Sci., 5(6):58.
1966. Observations of two Colorado shrews in captivity. Wasmann Jour. Biol., 24:75-81.
POOLE, A. J., AND V. S. SCHANTZ
1942. Catalog of type specimens of mammals in the United States National Museum, including the Biological Surveys collections. Bull. U.S. Nat. Mus., 178:xiii+1-705.
PORTER, K.
1959. Effects of subalpine timber cutting on wildlife in Colorado. Quart. Rept., Federal Aid Div., Dept. of Game and Fish, 1:151-185, processed.
POTTS, M. K.
1937. Hemorrhagic septicemia in the bighorn of Rocky Mountain National Park. Jour. Mamm., 18:105-106.
1938. Observations on diseases of bighorn in Rocky Mountain National Park. Trans. 3rd North Amer. Wildlife Conf., 893-897.
PREBLE, E. A.
1899. Revision of the jumping mice of the genus *Zapus*. N. Amer. Fauna, 15:1-42.
PRENSLOW, E. J., D. L. GILBERT, AND F. A. GLOVER
1968. Some behavior patterns of the pronghorn. Spec. Rept., Colorado Dept. of Game, Fish and Parks, 17:iv+1-16.
PRESNALL, C. C., AND A. WOOD
1953. Coyote predation on sage grouse. Jour. Mamm., 34:127.

Pruitt, W. O., Jr.
1954. Notes on Colorado *Phenacomys* and pikas. Jour. Mamm., 35:450-452.

Quick, H. F.
1951. Notes on the ecology of weasels in Gunnison County, Colorado. Jour. Mamm., 32: 281-290.
1964. Survey of the mammals. Pp. 81-89, *in* The natural history of the Boulder area (H. G. Rodeck, ed.), Leaflet, Univ. Colorado Mus., 13:iii+1-100.

Ramaley, F.
1939. Sandhill vegetation in northeastern Colorado. Ecol. Monogr., 9:1-51.
1942. Vegetation of the San Luis Valley in southern Colorado. Univ. Colorado Studies, Ser. D, 1:231-277.

Ramey, C. A., and D. J. Nash
1971. Abert's squirrel in Colorado. Southwestern Nat., 16:125-126.

Rapp, W. F., Jr.
1962. Notes on a small collection of fleas from Crowley County, Colorado. Jour. Kansas Entomol. Soc., 34:216-218.

Rausch, R.
1953. On the status of some Arctic mammals. Arctic, 6:91-148.
1963. Geographic variation in size in North American brown bears, Ursus arctos L., as indicated by condylobasal length. Canadian Jour. Zool., 41:33-45.

Reed, E. B.
1955. January breeding of *Peromyscus* in north central Colorado. Jour. Mamm., 36:462-463.
1957. Mammal remains from pellets of Colorado barn owls. Jour. Mamm., 38:135-136.

Rees, J. W., R. A. Kainer, and R. W. Davis
1966. Histology, embryology and gross morphology of the mandibular dentition in mule deer. Jour. Mamm., 47:640-654.

Reid, V. H., R. M. Hansen, and A. L. Ward
1966. Counting mounds and earth plugs to census mountain pocket gophers. Jour. Wildlife Mgt., 30:327-334.

Remington, J. D.
1952. Food habits, growth, and behavior of two captive pine martens. Jour. Mamm., 33: 66-70.
1953. Fur bearers of Colorado. Educ. Pamphlet, Colorado Game and Fish Dept., 4:1-18.
1955. Fur resources and bear studies. Final Rept., Federal Aid in Wildlife Studies, Project W-61-R, 85 pp., processed.

Retzer, J. L.
1956. Alpine soils of the Rocky Mountains. Jour. Soil Sci., 7:22-32.

Retzer, J. L., H. M. Swope, J. D. Remington, and W. H. Rutherford
1956. Suitability of physical factors for beaver management in the Rocky Mountains of Colorado. Tech. Bull., Colorado Dept. of Game and Fish, 2:1-32.

Rice, D. W.
1957. Sexual behavior of tassel-eared squirrels. Jour. Mamm., 38:129.

Richards, R. E.
1968. The ringtail *(Bassariscus astutus)* in Colorado: a preliminary report. Jour. Colorado-Wyoming Acad. Sci., 6(1):61-62.

Richmond, G. S.
1965. Glaciation of the Rocky Mountains. Pp. 217-230, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

Robinson, W. B.
1961. Population changes of carnivores in some coyote-control areas. Jour. Mamm., 42: 510-515.

Rodeck, H. G.
1952. Guide to the mammals of Colorado. Leaflet, Univ. Colorado Mus., 10:1-72.

Rodeck, H. G., ed.
1964. Natural history of the Boulder area. Leaflet, Univ. Colorado Mus., 13:iii+1-100.

Rodeck, H. G., and S. Anderson
1956. *Sorex merriami* and *Microtus mexicanus* in Colorado. Jour. Mamm., 37:436.

Roe, F. G.
1970. The North American buffalo, a critical study of the species in its wild state. Univ. Toronto Press, Toronto, xi+991 pp.

Rogers, C. M.
1953. The vegetation of the Mesa de Maya Region of Colorado, New Mexico, and Oklahoma. Lloydia, 16:257-290.

Roosevelt, T.
1901. With the cougar hounds. Scribner's Mag., 30:417-435, 545-564.

Russell, R. J.
1968. Revision of pocket gophers of the genus Pappogeomys. Univ. Kansas Publ., Mus. Nat. Hist., 16:581-776.

Rutherford, W. H.
1953. Effects of a summer flash flood upon a beaver population. Jour. Mamm., 34:261-262.
1954. A record of the ringtail *(Bassariscus astutus)* in Colorado. Jour. Mamm., 35:442-443.
1964. The beaver in Colorado. Tech. Bull., Colorado Game, Fish and Parks Dept., 17:1-49.

Ryan, R. M.
1963. The biotic provinces of Central America as indicated by mammalian distribution. Acta Zool. Mexicana, 6(2-3):1-54.

Sanderson, R. H.
1959. Relationships between jack rabbit use and availability of forage on native sandhills range. Unpublished master's thesis, Colorado State University, 85 pp.

Schantz, V. S.
1943. Mrs. M. A. Maxwell, a pioneer mammalogist. Jour. Mamm., 464-466.

1950. A new badger from Montana. Jour. Mamm., 31:90-92.

Scheffer, T. H.
1947. Ecological comparisons of the plains prairie-dog and the Zuni species. Trans. Kansas Acad. Sci., 49:401-406.

Scheffer, V. B.
1958. Do fossorial rodents originate mima-type microrelief? Amer. Midland Nat., 50:505-510.

Schumm, S. A.
1965. Quaternary paleohydrology. Pp. 783-794 *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

Scott, G. R.
1960. Subdivision of the Quaternary alluvium east of the Front Range near Denver, Colorado. Bull. Geol. Soc. America, 71:1541-1543.
1963. Quaternary geology and geomorphic history of the Kassler Quadrangle, Colorado. Prof. Paper, U.S. Geol. Surv., 421-A:1-70.
1965. Nonglacial Quaternary geology of the Southern and Middle Rocky Mountains. Pp. 243-254, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

Scott, G. R., and R. W. Lindvall
1970. Geology of new occurrences of Pleistocene bisons and peccaries in Colorado. Prof. Paper, U.S. Geol. Surv., 700-B:141-149.

Seton, E. T.
1920. The jaguar in Colorado. Jour. Mamm., 1:241.
1929. Lives of game animals. . . . Doubleday, Doran and Co., Garden City, N.Y., 4 vols.
1933. Occurrence of the least weasel near Denver. Jour. Mamm., 14:70.

Setzer, H. W.
1949. Subspeciation in the kangaroo rat, Dipodomys ordii. Univ. Kansas Publ., Mus. Nat. Hist., 1:473-573.

Shantz, H. L.
1917. Plant succession on abandoned prairie roads in eastern Colorado. Jour. Ecol., 5:19-42.
1923. The natural vegetation of the Great Plains Region. Ann. Assoc. Amer. Geogr., 13:81-107.

Shelford, V. E.
1932. Life zones, modern ecology, and the failure of temperature summing. Wilson Bull., 44:144-157.

Shirer, H. W., and J. F. Downhower
1968. Radio tracking of dispersing yellow bellied marmots. Trans. Kansas Acad. Sci., 71:463-479.

Short, H. L.
1964. Notes and comments on mandibular malformations in deer. Jour. Mamm., 45:319-321.

Short, H. L., and C. P. Short
1964. Abnormal dentition in a Colorado mule deer. Jour. Mamm., 45:315.

Silver, J.
1927. The introduction and spread of house rats in the United States. Jour. Mamm., 8:58-60.
1928. Badger activities in prairie-dog control. Jour. Mamm., 9:63.

Simpson, G. G.
1960. Notes on the measurement of faunal resemblance. Amer. Jour. Sci., 258-A:300-311.
1964. Species density of North American Recent mammals. Syst. Zool., 13:57-73.
1965. The geography of evolution, collected essays. Capricorn Books, New York, 249 pp.

Skinner, M. F., and O. C. Kaisen
1947. The fossil *Bison* of Alaska and preliminary revision of the genus. Bull. Amer. Mus. Nat. Hist., 89:123-256.

Skinner, M. P.
1922. The prong-horn. Jour. Mamm., 3:82-105.

Skryja, D. D., and T. W. Clark
1970. Reproduction, seasonal changes in body weight, fat deposition, spleen and adrenal gland weight of the golden-mantled ground squirrel, *Spermophilus lateralis lateralis* (Sciuridae) in the Laramie Mountains, Wyoming. Southwestern Nat., 15:201-208.

Smead, J. L.
1938. Second Colorado record of Tadarida macrotis. Jour. Mamm., 19:104.

Smith, J. D.
1964. Systematics of the plains harvest mouse, Reithrodontomys montanus. Unpublished master's thesis, University of Kansas, 42 pp.

Smith, J. D., and T. E. Lawlor
1964. Additional records of the armadillo in Kansas. Southwestern Nat., 9:48-49.

Smith, P. W.
1958. An analysis of post-Wisconsin biogeography of the Prairie Peninsula Region based on distributional phenomena among terrestrial vertebrate populations. Ecology, 38:205-218.
1961. The amphibians and reptiles of Illinois. Bull. Illinois Nat. Hist. Surv., 28:1-298.

Sokal, R. R., and P. H. H. Sneath
1963. Principles of numerical taxonomy. W. H. Freeman and Co., San Francisco, xvi+359 pp.

Spahn, J. J.
1954. Wolverine. Colorado Conservation, 3(2):1-3.

Sparks, D. R.
1968a. Occurrence of milk in stomachs of young jackrabbits. Jour. Mamm., 49:324-325.
1968b. Diet of black-tailed jackrabbits on sandhill rangeland in Colorado. Jour. Range Mgt., 21:203-208.

Spencer, A. W.
1966. Identification of the dwarf shrew, *Sorex nanus*. Jour. Colorado-Wyoming Acad. Sci., 5(7):89.

Spencer, A. W., and D. Pettus
1966. Habitat preferences of five sympatric species of long-tailed shrews. Ecology, 47: 677-683.

Spencer, A. W., and H. W. Steinhoff
1968. An explanation of geographic variation in litter size. Jour. Mamm., 49:281-286.

Spencer, C. C.
1942. Antelope with locked horns. Jour. Mamm., 23:92.
1943. Notes on the life history of the Rocky Mountain bighorn sheep in the Tarryall Mountains of Colorado. Jour. Mamm., 24: 1-11.

Stains, H. J., and R. L. Packard
1955. Occurrence of the mink, west of the Hundredth Meridian, in Kansas. Trans. Kansas Acad. Sci., 58:222-224.

Stark, J. T., J. H. Johnson, C. H. Behre, Jr., W. E. Powers, A. L. Howland, D. B. Gould and Others
1949. Geology and origin of South Park, Colorado. Mem. Geol. Soc. America, 33:viii+ 1-188.

Starrett, A., and P. Starrett
1956. Merriam shrew, *Sorex merriami*, in Colorado. Jour. Mamm., 37:276-277.

Stearns, C. E.
1942. A fossil marmot from New Mexico and its climatic significance. Amer. Jour. Sci., 240: 867-878.

Stephens, F.
1900. Descriptions of two new mammals from southern California. Proc. Biol. Soc. Washington, 13:153-158.

Stock, A. D.
1962. Endoparasites of mammals found in the Curecanti area of Gunnison County, Colorado. Anthro. Papers, Univ. Utah, 59:161-166.

Storer, T. I., and P. W. Gregory
1934. Color aberrations in the pocket gopher and their probable genetic explanation. Jour. Mamm., 15:300-312.

Streeter, R. G., and C. E. Braun
1968. Observations of pine marten in Colorado alpine areas, 1966-1967. Jour. Colorado-Wyoming Acad. Sci., 6(1):62.

Sutton, D. A.
1953. A systematic review of Colorado chipmunks (genus *Eutamias*). Unpublished doctoral dissertation, University of Colorado, 208 pp.
1954. A systematic review of Colorado chipmunks (Abstract). Bull. Univ. Colorado, Gen. Ser., 29(3):44-46.
1962. A temporary preservative for small mammals. Jour. Mamm., 43:264-265.

Sutton, D. A., and C. F. Nadler
1969. Chromosomes of the North American chipmunk genus *Eutamias*. Jour. Mamm., 50: 524-535.

Svihla, A.
1932. A comparative life history study of the mice of the genus *Peromyscus*. Misc. Publ., Univ. Michigan Mus. Zool., 24:1-39.

Swenk, M. H.
1916. On a new subspecies of porcupine from Nebraska. Univ. Nebraska Studies, 16: 115-125.
1926. Notes on Mustela campestris Jackson, and on the American forms of least weasels. Jour. Mamm., 7:313-330.

Swift, L. W.
1945. A partial history of the elk herds of Colorado. Jour. Mamm., 26:114-119.

Tate, G. H. H.
1947. Albino prairie-dog. Jour. Mamm., 28:62.

Taylor, D. W.
1965. The study of Pleistocene nonmarine molluscs in North America. Pp. 597-611, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.

Taylor, W. P., ed.
1956. The deer of North America. . . . The Stackpole Co., Harrisburg, and Wildlife Mgt. Inst., Washington, xvii+668 pp.

Tester, J. R.
1953. Fall food habits of the raccoon in the South Platte Valley of northeastern Colorado. Jour. Mamm., 34:500-502.

Thaeler, C. S., Jr.
1968. Karyotypes of sixteen populations of the *Thomomys talpoides* complex of pocket gophers (Rodentia—Geomyidae). Chromosoma, 25:172-183.

Thornbury, W. D.
1965. Regional geomorphology of the United States. John Wiley and Sons, New York, ix+609 pp.

Tietjen, H. P., C. H. Halvorsen, P. L. Hegdal, and A. M. Johnson
1967. 2, 4-D herbicide, vegetation, and pocket gopher relationships, Black Mesa, Colorado. Ecology, 48:634-643.

Tigner, J. R., and D. L. Gilbert
1960. A contribution toward a bibliography on the black bear. Tech. Bull., Colorado Dept. of Game and Fish, 5:1-42.

Tileston, J. V., and R. R. Lechleitner
1966. Some comparisons of the black-tailed and white-tailed prairie dogs in north-central Colorado. Amer. Midland Nat., 75:292-316.

Tileston, J. V., and L. E. Yeager
1962. A resume of Colorado big game research projects, 1939-1957. Tech. Bull., Colorado Dept. of Game and Fish, 9:1-81.

TILL, C. E.
1954. White-tailed deer in Colorado. Jour. Mamm., 35:269.

TOLMAN, C. D.
1949. Productivity of mule deer in Colorado. Trans. 15th North Amer. Wildlife Conf., 589-596.

TOMBERLIN, D. R.
1968. Population ecology of two chipmunk populations in southern central Colorado. Jour. Colorado-Wyoming Acad. Sci., 6(1):63-64.

TRIPPE, T. M.
1874. Appendix to Oscines, A. Pp. 223-233 *in* E. Coues, Birds of the northwest. . . . Misc. Publ., U.S. Geol. Surv. Territories, 3:xi+1-791.

TULLY, R. J.
1970. Status of the grizzly bear in Colorado. Report to Special Grizzly Bear Committee, International Association of Game, Fish and Conservation Commissioners, Mack's Inn, Idaho, 7 July, 3 pp. (processed).

TURKOWSKI, F. J., AND H. G. REYNOLDS
1970. Response of some rodent populations to pinyon-juniper reduction on the Kaibab Plateau, Arizona. Southwestern Nat., 15: 23-27.

TURNER, G. T., AND D. F. COSTELLO
1942. Ecological aspects of the prickly-pear problem in eastern Colorado and Wyoming. Ecology, 23:419-426.

TURNER, R. W.
1968. Olive-backed pocket mouse in southern Colorado. Jour. Mamm., 49:524.

UDVARDY, M. D. F.
1963. Bird faunas of North America. Proc. 13th Int. Ornith. Cong., pp. 1147-1167.
1969. Dynamic zoogeography with special reference to land animals. Van Nostrand, Reinhold Co., New York, xviii+445 pp.

UNITED STATES DEPARTMENT OF AGRICULTURE
1938. Soils and men, the yearbook of agriculture. Government Printing Office, Washington, 1232 pp.

UNITED STATES DEPARTMENT OF THE INTERIOR
1966. Mammals, *in* Rare and endangered fish and wildlife of the United States. Resource Publ., Bureau of Sport Fisheries and Wildlife, 34:Mi-ii+M1-30.

UPSON, J. E.
1939. Physiographic subdivisions of the San Luis Valley, southern Colorado. Jour. Geol., 47:721-736.

VAN GELDER, R. G.
1959. A taxonomic revision of the spotted skunks (genus *Spilogale*). Bull. Amer. Mus. Nat. Hist., 117:229-392.
1968. The genus *Conepatus* (Mammalia, Mustelidae): variation within a population. Amer. Mus. Novit., 2322:1-36.

VAUGHAN, T. A.
1961a. Vertebrates inhabiting pocket gopher burrows in Colorado. Jour. Mamm., 42:171-174.
1961b. Cranial asymmetry in the pocket gopher. Jour. Mamm., 42:412-413.
1962. Reproduction of the plains pocket gopher in Colorado. Jour. Mamm., 43:1-13.
1963. Movements made by two species of pocket gophers. Amer. Midland Nat., 69:367-372.
1966. Food handling and grooming behavior in the plains pocket gopher. Jour. Mamm., 47:132-133.
1967a. Food habits of the northern pocket gopher on shortgrass prairie. Amer. Midland Nat., 77:176-189.
1967b. Two parapatric species of pocket gophers. Evolution, 21:148-158.
1969. Reproduction and population densities in a montane small mammal fauna. Pp. 51-74, *in* Contributions in mammalogy (J. K. Jones, Jr., ed.), Misc. Publ., Univ. Kansas Mus. Nat. Hist., 51:1-428.

VAUGHAN, T. A., AND R. M. HANSEN
1961. Activity rhythm of the plains pocket gopher. Jour. Mamm., 42:541-543.
1964. Experiments on interspecific competition between two species of pocket gophers. Amer. Midland Nat., 72:444-452.

VON BLOEKER, J. C., JR.
1944. New locality records for some west American shrews. Jour. Mamm., 25:311-312.

WADE, O.
1935. Notes on the northern tuft-eared squirrel, Sciurus aberti ferreus True, in Colorado. Amer. Midland Nat., 16:201-202.

WADE, O., AND P. T. GILBERT
1940. The baculum of some Sciuridae and its significance in determining relationships. Jour. Mamm., 21:52-63.

WADSWORTH, C. E.
1969. Reproduction and growth of *Eutamias quadrivittatus* in southeastern Utah. Jour. Mamm., 50:256-261.

WALKER, E. P.
1945. Notes on the feeding habits of Citellus and Eutamias. Jour. Mamm., 26:308.

WARD, A. L.
1960. Mountain pocket gopher food habits in Colorado. Jour. Wildlife Mgt., 24:89-92.

WARD, A. L., AND J. O. KEITH
1962. Feeding habits of pocket gophers in mountain grasslands, Black Mesa, Colorado. Ecology, 43:744-749.

WARDLE, P.
1968. Engelmann spruce (*Picea engelmannii* Engel.) at its upper limits on the Front Range, Colorado. Ecology, 49:483-495.

WARING, G. H.
1966a. Sounds and communication of the yellow-bellied marmot *(Marmota flaviventris)*. Anim. Behav., 14:177-183.
1966b. Alarm behaviors of the black-tailed, white-tailed, and Gunnison's prairie dogs. Jour. Colorado-Wyoming Acad. Sci., 5(7):95.

1969. The blow sound of pronghorns *(Antilocapra americana)*. Jour. Mamm., 50:647-648.
1970. Sound communications of black-tailed, white-tailed and Gunnison's prairie dogs. Amer. Midland Nat., 83:167-185.

WARREN, E. R.
1905. Some interesting beaver dams in Colorado. Proc. Washington Acad. Sci., 6:429-437.
1906. Mammals of Colorado. Colorado College Publ., Gen. Ser., 19 (Sci. Ser., 46):225-274.
1908a. Northwestern Colorado bird-notes. Condor, 10:18-26.
1908b. Further notes on the mammals of Colorado. Colorado College Publ., Gen. Ser., 33 (Engineering Ser., 1):59-90.
1909. A new chipmunk from Colorado. Proc. Biol. Soc. Washington, 22:105-106.
1910a. Some central Colorado bird notes. Condor, 12:23-39.
1910b. Mammals of Colorado. . . . Putnam, New York, xxxiv+300 pp.
1911. The history of Colorado mammalogy. Colorado College Publ., Gen. Ser., 54 (Sci. Ser., 12):312-328.
1912a. Notes on the distribution of some Colorado mammals. Proc. Biol. Soc. Washington, 25:3-8.
1912b. Some north-central Colorado bird notes. Condor, 14:81-104.
1913a. Additional notes on the distribution of Colorado mammals. Proc. Biol. Soc. Washington, 26:9-12.
1913b. Dichromatism in *Neotoma mexicana fallax* from Costilla County, Colorado. Proc. Biol. Soc. Washington, 26:35-38.
1916. Notes on the birds of the Elk Mountain region, Gunnison County, Colorado. Auk, 33:292-317.
1919. Notes on wood rat work. Jour. Mamm., 1:233.
1921. The hog-nosed skunk *(Conepatus)* in Colorado. Jour. Mamm., 2:112.
1924. A muskrat moves its young. Jour. Mamm., 5:202.
1926a. Notes on the breeding of wood rats of the genus *Neotoma*. Jour. Mamm., 7:97-101.
1926b. Dwarf marmots. Jour. Mamm., 7:332-333.
1926c. Beaver in the Pikes Peak region. Trail and Timberline, 98:4-6.
1927a. Altitude limit of bison. Jour. Mamm., 8: 60-61.
1927b. The beaver: its work and its ways. Monogr., Amer. Soc. Mammal., 2:1-177.
1927c. Notes on the beaver colonies in the Longs Peak region of Estes Park, Colorado. Roosevelt Wildl. Ann., New York State College of Forestry, 1:192-234.
1928a. The most interesting wild animal in America. Sci. Monthly, 27:33-41.
1928b. Little mountaineers in fur. Trail and Timberline, 17:2-3.
1928c. Cutting of oaks by beavers. Jour. Mamm., 9:253-254.
1928d. Beavers in the Elk Mountain region, Colorado. Jour. Mamm., 9:320-334.
1929. An albino field mouse. Jour. Mamm., 10: 82.
1932a. When do weasels mate? Jour. Mamm., 13: 71-72.
1932b. Position of wood in beaver dams. Science, 75:194-195.
1932c. A somewhat unusual kitchen midden of Fremont's squirrel (Sciurus fremonti fremonti). Jour. Mamm., 13:278.
1932d. Twenty years in a beaver pond. Amer. Forests, 38:444-447.
1932e. The abandonment and reoccupation of pond sites by beavers. Jour. Mamm., 13:343-346.
1932f. The grizzly bears of Colorado. Proc. Colorado Mus. Nat. Hist., 11(3):19-24.
1935a. A pocket gopher at work. Jour. Mamm., 16:153.
1935b. Notes on the voice of marmots. Jour. Mamm., 16:153-154.
1936. The marmots of Colorado. Jour. Mamm., 17:392-398.
1937. Notes on pocket gophers. Jour. Mamm., 18:473-477.
1938. The work of beavers. Sci. Monthly, 47: 176-181.
1940. A beaver's food requirements. Jour. Mamm., 21:93.
1942. The mammals of Colorado. . . . Univ. Oklahoma Press, Norman, 2nd revised edition, xviii+330 pp.

WARREN, E. R., AND E. R. HALL
1939. A new subspecies of beaver from Colorado. Jour. Mamm., 20:358-362.

WATERS, S. A., ED.
1958. Colorado, 1956-1958. Colorado State Planning Division, Denver, vii+871 pp.

WEAVER, J. E., AND F. W. ALBERTSON
1940. Deterioration of midwestern ranges. Ecology, 21:216-236.
1956. The grasslands of the Great Plains. Johnsen Publ. Co., Lincoln, 395 pp.

WEBB, W. L.
1950. Biogeographic regions of Texas and Oklahoma. Ecology, 31:426-433.

WEBER, W. A.
1965. Plant geography in the Southern Rocky Mountains. Pp. 453-468, *in* The Quaternary of the United States (H. E. Wright, Jr., and D. G. Frey, eds.), Princeton Univ. Press, Princeton, x+922 pp.
1967. Rocky Mountain flora. Univ. Colorado Press, Boulder, viii+437 pp.

WELCH, D.
1934. Bears in Estes Park, Colorado. Jour. Mamm., 15:242.

WHITE, J. A.
1953a. Taxonomy of the chipmunks, *Eutamias*

quadrivittatus and *Eutamias umbrinus*. Univ. Kansas Publ., Mus. Nat. Hist., 5: 563-582.

1953b. Geographic distribution and taxonomy of the chipmunks of Wyoming. Univ. Kansas Publ., Mus. Nat. Hist., 5:583-610.

1953c. The baculum in the chipmunks of western North America. Univ. Kansas Publ., Mus. Nat. Hist., 5:611-631.

Wilkinson, E.

1965. Some facts and fallacies about wild animals. Colorado Outdoors, 14(5):34-39.

Williams, D. F., J. D. Druecker, and H. L. Black

1970. The karyotype of *Euderma maculatum* and comments on the evolution of plecotine bats. Jour. Mamm., 51:602-606.

Williams, O.

1952. New Phenacomys records from Colorado. Jour. Mamm., 33:399.

1955a. Home range of *Peromyscus maniculatus rufinus* in a Colorado ponderosa community. Jour. Mamm., 36:42-45.

1955b. Distribution of mice and shrews in a Colorado montane forest. Jour. Mamm., 36: 221-231.

1959a. Food habits of the deer mouse. Jour. Mamm., 40:415-419.

1959b. Water intake in the deer mouse. Jour. Mamm., 40:602-606.

Williams, O., and B. A. Finney

1964. Endogone—food for mice. Jour. Mamm., 45:265-271.

1967. Small mammals on Jumbo Mountain: 1960-1966. Jour. Colorado-Wyoming Acad. Sci., 5(8):74.

Williams, T. R.

1957. Marten and hawk harass snowshoe hare. Jour. Mamm., 38:517-518.

Williams, T. W., and E. E. Holch

1946. Ecology of the Black Forest of Colorado. Ecology, 27:139-149.

Wilson, D. E.

1968. Ecological distribution of the genus *Peromyscus*. Southwestern Nat., 13:267-274.

Wilson, E. O., and W. L. Brown, Jr.

1953. The subspecies concept and its taxonomic application. Syst. Zool., 2:97-111.

Woodin, H. E., and A. A. Lindsey

1954. Juniper-pinyon east of the Continental Divide, as analyzed by the line-strip method. Ecology, 35:474-489.

Wright, G. M., J. S. Dixon, and B. H. Thompson

1933. Fauna of the National Parks of the United States—a preliminary survey of faunal relations in National Parks. Fauna Ser., Wild Life Survey, 1:iv+1-157.

Yeager, L. E.

1950. Implications of some harvest and habitat factors of pine marten management. Trans. 15th North Amer. Wildlife Conf., 319-334.

1959. Status and population trend of fox squirrels on fringe range, Colorado. Jour. Wildlife Mgt., 23:102-107.

Yeager, L. E., and K. G. Hay

1955. A contribution toward a bibliography on the beaver. Tech. Bull., Colorado Dept. of Game and Fish, 1:ii+1-103.

Yeager, L. E., and R. R. Hill

1954. Beaver management problems on western public lands. Trans. 19th North Amer. Wildlife Conf., 462-478.

Yeager, L. E., and J. D. Remington

1956. Sight observations of Colorado martens. Jour. Mamm., 37:521-524.

Yeager, L. E., and L. E. Riordan

1953. Effects of beetle-killed timber on range and wildlife in Colorado. Trans. 18th North Amer. Wildlife Conf., 596-616.

Yeager, L. E., and W. H. Rutherford

1957. An ecological basis for beaver management in the Rocky Mountain Region. Trans. 22nd North Amer. Wildlife Conf., 269-300.

Yeager, L. E., and J. P. Woloch

1962. Striped skunk with three legs. Jour. Mamm., 43:420-421.

Young, R. T.

1908. Notes on the distribution of Colorado mammals, with description of a new species of bat *(Eptesicus pallidus)* from Boulder. Proc. Acad. Nat. Sci. Philadelphia, 60: 403-409.

Young, S. P.

1927. Mountain lion eats its kittens. Jour. Mamm., 8:158-160.

1928. Bobcat kills deer. Jour. Mamm., 9:64-65.

1944a. Longevity and other data on a male and female prairie dog kept as pets. Jour. Mamm., 25:317-319.

1944b. Their history, habits, economic status, and control. Pp. 1-385, *in* S. P. Young and E. A. Goldman, The wolves of North America. Amer. Wildlife Inst., Washington, xvi+636 pp.

1946. History, life habits, economic status, and control. Pp. 1-173, *in* S. P. Young, and E. A. Goldman, The puma, mysterious American cat. Amer. Wildlife Inst., Washington, xiv+358 pp.

1951. Its history, life habits, economic status and control. Pp. 1-226, *in* S. P. Young and H. H. T. Jackson, The clever coyote. The Stackpole Co., Harrisburg, and Wildlife Mgt. Inst., Washington, xv+411 pp.

1958. The bobcat of North America, its history, life habits, economic status and control, with list of currently recognized subspecies. The Stackpole Co., Harrisburg, and Wildlife Mgt. Inst., Washington, xi+193 pp.

Young, S. P., and R. H. Manville

1960. Records of bighorn hybrids. Jour. Mamm., 31:523-555.

Youngman, P. M.

1958. Geographic variation in the pocket gopher, Thomomys bottae, in Colorado. Univ. Kansas Publ., Mus. Nat. Hist., 9:363-384.

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